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Population, Environment, and Development: Interactions and Issues

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Background paper for the Conference on Population, Environment, and Development organized by the Tata Energy and Resources Institute, USA 13 and 14 March, 1996.

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Abstract

The paper examines the relationship between population, environment, and development with specific reference to the developing world, i.e. countries who currently face the dual challenge of achieving high economic growth rates coupled with sustainability considerations. We outline the ways in which high fertility and environmental degradation can reinforce each other and address several issues central to the population and development arena. Lastly, we include two case studies of development: one for a high population, low consumption region, and one for a low population, high consumption country.

I. INTRODUCTION

Past development patterns have laid emphasis primarily on attaining high rates of economic growth with little regard for sustainability. In recent decades, the urbanization and industrialization associated with economic growth, coupled with a rapidly growing population, has had grave impacts on the environment and on the stock of natural resources. With the realization that past patterns have not been conducive to sustainable development, the focus has now shifted towards attaining a balance between the population size and available resources and the capability of the economy to provide basic needs within the limits imposed by the biosphere.

The World Commission for Environment and Development brought to the fore the concept of sustainable development in the 1987 report, *Our Common Future*. The Commission emphasized that present generations should "meet their needs without compromising the ability of future generations to meet their own needs .... Development can not subsist upon a deteriorating environmental base; the environment cannot be protected when growth leaves out of account the costs of environmental destruction. These problems can not be treated separately by fragmented institutions and policies. They are linked in a complex system of cause and effect."

Herman Daly (1993) views sustainability in terms of *scale*, i.e., the size of the economy in relation to the ecosystem. The economic system, being a physical subset of the ecosystem, cannot grow beyond the scale of the latter and undue emphasis on growth tends to push us beyond what is sustainable. Or in other words, in their effort to

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maintain their present scale of population and per capita consumption, many countries are consuming their natural capital and counting it as income. Thus, the most critical question is how to achieve sustainable development given the constraints imposed by population and the environment.

II. THE WORLD DEMOGRAPHIC PICTURE

The World population stands at 5.8 billion. This number is expected to rise to 6 billion by the turn of the century, and to reach nearly 8.5 billion by 2025. Table 1 shows total population over time with its regional distribution. Between 1950 and 1995, world population grew at the rate of 1.9 percent per annum compared with 0.9 percent in the half-century preceding 1950. As much as 83 percent of this increase was seen in Southern developing countries. Asia, excluding Japan, has the largest share of the world population -- 57 percent of the total -- which is concentrated primarily in China and India. Africa is currently experiencing the highest rate of growth of population at 3 percent per annum.

Table 1: ***World population trends from 1900 - 2100***

Region	1900*	1950	1995	2000*	2025	2100*
Developing world						
Africa	133	222	744	872	1583	2591
Asia	867	1294	3281	3419	4773	4919
Latin America	70	148	447	546	651	1238
Sub-total	1070	1664	4472	4837	7007	8748
Industrial World						
Europe, Japan,	478	656	931	987	1012	1055
North America	82	166	292	297	360	382
Sub-total	560	822	1223	1284	1372	1437
World	1630	2516	5759	6121	8472	10185

Sources: World Resources Institute, 1994, *World Resources, 1994-1995*
*Pearce and Warford, 1993, *World Without End*

The existing developed countries had experienced high rates of industrial growth concomitant with their growth of population. Thus, an increase in numbers in these countries did not pose a constraint to the development process. The developed countries of the North experienced a slow secular trend in population growth, with declining death rates and slowly rising birth rates. The natural population growth rate did not exceed 2 percent per annum. However, developing countries have shown very high rates in their early stages of development (more than 2.5 percent p.a), stemming largely from advances in medical science and reductions in mortality from disease. This decline in mortality rates in the face of relatively high fertility rates paired with the frequent lack of industrialization implies that the developed countries' experience cannot be emulated by the developing world.

III. THE POPULATION-ENVIRONMENT-DEVELOPMENT LINKAGE

Reproduction, particularly in developing countries, can be viewed as a microeconomic decision. Each child born confers benefits to the family not only in terms of personal happiness, but also in terms of labor productivity and old age security. The relevant costs of a child include food, clothing, and shelter, which have direct impacts on the family, but may also include government welfare, resource depletion, and waste generation, which are borne by society as a whole. It is the failure to account for these external costs in personal reproductive decision-making which leads to excess population, and it is these same costs that cause population to be seen as a societal problem.

The impact of population size on natural resources becomes significant when a growing population increasingly impinges on a resource base that is inelastic in supply (Mink, 1993). This implies a diminished per capita availability of resources and a negative impact on living standards. The impact on the environment is often looked at in terms of the concept of carrying capacity. Ehrlich and Holdren (1974) define carrying capacity as "the maximum number of individuals that can be supported by a given habitat; it is usually related to the availability of a limiting resource, one that is in short supply in relation to a population's needs." According to this definition, if nothing else changes, increasing populations will ultimately put demands on resources, and these demands will not be met without adverse effects on the ability of the natural environment to support the human populace. Carrying capacity cannot be considered in the abstract, however. The ability of the land to support human population can be complicated additionally by factors such as trade, consumption magnitude, and technology (Ramakrishnan, 1994).

The relationship quantified

In an attempt to quantify the relationship between population, environment, consumption and technology, Ehrlich and Holdren formulated the following simple identity:

$$I = P * A * T$$

where I represents the impact of population on the environment,
P represents population size,
A represents the level of affluence or per capita consumption of a resource and
T represents the environmental damage caused by the technology used in attaining that level of affluence.

The above equation does not take account of the vulnerability of the environment, or the cultural, economic, and institutional aspects of consumption and technology. However, it does show that environmental degradation can be caused by any of the three factors, by themselves, or in combination with the others. In cases where more than one of the factors increases simultaneously, there is an additional synergistic effect.

The relationship is complicated further by the interactions among the three right-hand-side factors (IIASA, 1994). For example, insofar as population growth can lead to

increased unemployment and shortages of food, it will be associated with a decrease in per capita consumption. Similarly, others argue that the same demographic growth will act to spur the evolution of adaptive technology (Boserup, 1965). And yet others point out that affluence increases the opportunity cost of children and would thus lead to a decrease in population. In short, there is a very intricate web of factors that play in the population-environment-development debate: demographic, technological, ecological, economic, and cultural -- all of which can have a positive or negative effect on the others. Thus, a search for a cause is largely ineffectual.

Focusing on population and the environment, we can see examples of this confusion (Mink, 1993). Demographic pressure in rural areas has been linked to growth in fuelwood collection and the associated deforestation. As collection time increases, it becomes desirable for a family to have additional help in the form of children. Thus fertility remains high or increases. This is an example of a positive feedback between environment and fertility. However, negative feedbacks exist as well. Population-induced agricultural land degradation can necessitate male urban migration (Qutub, 1992), and the resultant spousal separation has been correlated to fertility decline in rural areas.

Whether demographic changes will lead to the degradation of the environment and whether such degradation will have positive or negative feedback effects depends largely on the specific context of the situation. For example, Bilsborrow et al. (1992) discusses four ways in which rural agricultural systems can respond to demographic pressure, namely, through changes in land ownership and classification (*tenurial*), increases in area of land cultivated (*extensification*), modification of agricultural practices (*technological* or *intensification*), and reductions in fertility and delays in marriage (*demographic*). Any or all of these phases may occur, and each has its own implications for the environment and resource base. The context, namely the influence of institutional and political as well as natural factors, determines which of these is experienced.

Another example of the intricacies of context is provided by Taylor (1996). He refers to two hypothetical countries, both experiencing a rapid doubling of population. One country encounters environmental degradation and poverty almost immediately, while the other requires several generations before it suffers any of the same effects. The only difference between the two is the initial land distribution. It is as such that other factors can exacerbate the already complicated relationship between population and the environment.

IV. ISSUES RELATED TO THE IMPACTS OF POPULATION AND DEVELOPMENT

Although it is difficult to establish causality when dealing with the impacts of demographic change, it is often useful to examine environmental impacts in terms of several issues that are largely associated with population growth.

A. Poverty and Environment

Population seldom has direct impacts on the environment. The environmental impacts attributed to population occur as responses to poverty, and therefore, it is in its role as a contributing factor to poverty that population becomes an important environmental causative force.

Due to their economic status, the poor often have no choice but to inhabit marginal areas that are environmentally vulnerable and also lacking in modern infrastructure, and they don't have the means to counteract the adverse impacts of environmental degradation. Perhaps the most severe form of environmental pollution to which they are exposed is water pollution. The lack of adequate sanitation and access to safe drinking water is responsible for the incidence of diseases such as gastroenteritis, diarrhea or cholera. The poor are also exposed to health hazards due to indoor air pollution arising from the use of cheap biomass fuels such as wood, crop residues, and dung.

Those attempting to make a living on marginal lands frequently have deleterious impacts on those lands as well. Unsustainable intensive agricultural practices such as monocropping and shifting cultivation with short or no fallow periods can lead to nutrient depletion and salinization, and deforestation and farming on hill areas causes soil and wind erosion and flooding, not to mention losses in biodiversity.

Such degradation adversely affects the health of the poor and their capacity to work. They are made to divert a large proportion of their time to routine tasks such as the collection of fuelwood and water, which has associated high opportunity costs in terms of alternate sources of income. Moreover, declines in the productivity from illness and degraded resources further depresses their ability to generate income.

The degradation can be explained in terms of discount rates. Due to their circumstances, many poor place a very high time value on money, and those who would desire long planning horizons are unable to act accordingly (Mink, 1993). As a result of such high discount rates, the poor have no incentives to invest in environmentally sustainable practices, and often are forced to consume their resources, rather than utilizing them wisely as investments for the future. In addition to their financial plight, the poor's time value of money is reinforced by an unusually large burden of risk. Their welfare is highly vulnerable to health problems, weather and natural disaster, and political instability, and this risk contributes to their short-sightedness. To make matters worse, environmental degradation itself adds to the abundance of risk faced by the poor.

There is a distinction between the types of environmental degradation associated with poverty as compared to other causes, that is, a distinction between the effects of subsistence versus commercial consumption. The impacts described above are mostly local in nature and their effects are largely confined to the poor themselves. However, other types of degradation, e.g. outdoor air pollution, ozone depletion, acid rain, and non-renewable resource exhaustion all can be attributed to increases in consumption. This point is a subtle one, and its importance becomes clearer when we speak of policies.

Ironically, developmental activities can also have adverse impacts on the poor. For example, the construction of dams, though essential for the economy, tends to dislocate the population residing in those areas, as well as to cause the destruction of forests and biodiversity. Since the poor are heavily dependent on natural resources for their subsistence, such dislocation would, in turn, impose an additional burden on them. Furthermore, Arrhenius (1992) points out that an annual growth in global electric power consumption of 6 to 7 percent will lead to an 80 percent increase in carbon dioxide emissions, which is feared to be associated with a rise in sea level, and would have a disproportionate impact on the developing countries (Mhatab et al., 1992).

B. Urbanization and migration
A demographic trend that is of great concern for the future is urbanization. By the year 2015, 56 percent of the global population is expected to live in urban areas compared to 45 percent in 1994. Furthermore, most of this increase is likely to be concentrated in the developing countries where the level of urbanization is expected to rise to almost 50 percent from the present level of 26 percent.

The rate at which urbanization is taking place in the developing world is not different from the experience of the developed countries. However, the distinguishing feature is in terms of the size of the cities and the pace at which they are growing. European cities achieved a maximum rate of growth of 2.6 percent in the late 1800s and, as mentioned above, was accompanied by industrialization. Strikingly, in developing countries, the rate of growth is 1.5 percent more than that of the European countries (Mink, 1993). Further, at the start of their present modernization phase, the developing countries also have a large gap between industrial growth and population increase rates.

Rural-to-urban migration plays an important role in the growth of cities. Migration is usually a response to the imbalances between rural population levels and the capacity of the local resources to support that population. Whereas it was previously believed that migration to cities was a simple function of these population levels, the belief now is that population is only an indirect factor, and that economic prospects, land tenure, and agricultural productivity are the direct causes (Qutub, 1992).

The impacts of rural-to-urban migration are mixed in nature. On one hand, the rapid growth of population in urban centers has resulted in the widespread proliferation of slums and inequitable patterns of consumption and access to resources. Rising population densities in urban centers tend to place greater demands on urban infrastructure, particularly the provision of water and sanitation. Such patterns have implications for equitable economic development in light of the fact that vast proportions of populations residing in slums and squatter settlements rarely have access to basic infrastructure. Furthermore, migration leads to an increasing concentration of urban population, which tends to surpass the natural ability of urban environments to absorb wastes and emissions from human activities. Air and water pollution, and problems of waste disposal increasingly expose the population to various health hazards.

On the other hand, urban areas are a more efficient use of space than are their rural counterparts, and generally have associated the benefits of infrastructural scale

economies, the substitution of the use of abundant resources for scarce ones, and a reduction in the impact on open natural areas (ibid.). Demographically, they have also been linked to a relative reduction in fertility (as compared to rural areas) resulting from better job security and educational opportunities (Pearce, 1993).

Rural-to-rural (or circular) migration is the other type of demographic response of interest. This type of migration is largely associated with agricultural land extensification, but may be caused by some of the same factors as rural-to-urban movements. One obvious benefit of migration from rural areas experiencing demographic and economic pressure is the reduction of impacts in these areas on the local environment (Mink, 1993). However, many of the lands to which people are migrating are marginal and require slightly different agricultural practices, and are environmentally vulnerable to the new inhabitants (ibid.). Another cost of such an action is the social psychological disruption that occurs when a significant portion of the locality leaves the area (Taylor, 1996). Many resource conservation practices depend on local social institutions, which may be undermined by rural out-migration.

C. Food security

Food security was defined at the 1974 World Food Conference as "physical and economic access to food to all people at all times (Swaminathan, 1993)." In most developing countries these norms are not met and chronic hunger prevails. However, this situation is more a problem of distribution than one of aggregate supply, and the theory propounded nearly 200 years ago by Thomas Malthus that population growth would outstrip food production has not been supported in reality. The past two centuries have provided ample evidence of the benefits of technological innovation. Between 1960 and 1990, the Green Revolution led to a tripling of food production and a fall in the proportion of malnourished in developing countries from 36 percent to 20 percent (ibid.).

As a measure of the carrying capacity of the earth, scientists have attempted to estimate the total production ability of the earth's land if it were completely dedicated to food production. The UN Food and Agriculture Organization found that at intermediate levels of technology, the total biological potential of the planet is four times the projected population for 2000 (Pearce et al., 1993). While this seems promising, the authors warn that at low levels of technology and allowing for the production of non-food crops (e.g. cotton, tobacco, etc.), the world's capacity falls to only 1.07 times the 2000 population. Furthermore, the model assumes a subsistence standard of living and does not allow for increases in nutritional status. Clearly there is a need for continued agricultural growth in the face of the expected increase in population.

Apart from the issue of hunger and malnutrition, it is necessary to consider the question of long-term resource constraints which have been overlooked in the pursuit of attaining higher levels of agricultural production. The architect of the Green Revolution, Norman Borlaug, had warned that agricultural advances would be of a temporary nature. We have already begun to experience diminishing returns. This decade has seen a decrease in the growth of world grain production, from a 1990 harvest of 1.78 billion tons of grain to 1.69 billion tons in 1995, corresponding to a record low carryover stock of 49

days of consumption (Brown, 1996). In addition, the use of high yield crop varieties, fertilizers, and pesticides, and the expansion of irrigated land has not been without a cost. The intensive utilization of fertilizers and hazardous chemicals to keep ahead of pest evolution contributes to both surface and ground water pollution; over-use of land for cultivation and grazing has contributed towards accelerated erosion and desertification in many regions; and the world could be losing 14 million additional tonnes of grain output each year due to land degradation and crop damage on account of factors like flooding and pollution (Mink, 1993).

A rise in the demand for food largely due to an increase in population imposes a demand for bringing in more land under cultivation. In an econometric study by Southgate, it was inferred that as population growth rates increased, these countries experienced an expansion in agricultural area (ibid.). This growth in agricultural land area is also likely to place greater pressure on biodiversity, mainly through deforestation.

Thus, although past experience has been encouraging and modern agriculture has been able to meet the demands for food by a growing population, it does not provide ground for complacency. It must be emphasized, at the same time, that even though there has been progress in agricultural production, chronic hunger still persists in many parts of the world. The problem of equitable distribution has not been addressed with the seriousness it deserves, as the recent cases of famines in parts of Africa have shown. Thus, food security entails eliminating chronic hunger and starvation while arresting the degradation of environmental capital stocks so as to enable sustainable agricultural production.

D. Consumption and the North-South debate

A point of much contention between the North and South is whether poverty or affluence contributes more to environmental problems. As we have seen, in developing countries, natural resource depletion is a means of meeting the needs of an impoverished population. In fact, poverty itself may be a prominent, if not the chief, incentive for a large family. In most developing countries, children from a young age engage in the tasks of collecting fuel, fodder, and timber for the household and, in that sense, are "productive assets" for the family. As the population in developing countries continues to grow, they make an ever-increasing contribution to total world consumption.

On the other hand, despite lower levels of population, developed countries consume far more resources per capita than their developing counterparts, thereby multiplying the strain on natural resources. For example, one American is estimated to consume the same amount of energy as 14 Chinese and 38 Indians (Goodland, 1994). According to 1990 World Energy Council estimates, North America consumed 7.82 tonnes of oil equivalent (TOE) of primary energy per capita. In contrast, Western Europe consumed 3.22 TOE of primary energy per capita, CIS, 5.01 and Central and Eastern Europe, 2.91. These figures were vastly lower for sub-Saharan Africa at 0.53 TOE per capita and for South Asia at 0.39.

The disparities in consumption levels are not limited to petroleum products. Table 2 makes comparisons between developing and developed countries for several natural

resources. It can be seen that in almost every case, the industrialized regions consume a full order of magnitude more than developing countries. The table shows that the largest differences lie in metals and fossil fuels, which is consistent with the gaps in industrial production between the two.

Although the majority of consumption-driven degradation is experienced by the consuming countries themselves, e.g. soil erosion in developing countries and automobile emissions in industrialized countries, there are indirect effects from the flow of materials through trade. For example, about two thirds of developing countries' agricultural and industrial raw material exports are to industrial countries (WRI, 1994). Thus the demand for production inputs by the North may indirectly contribute to environmental degradation in the South.

Table 2. *Comparative resource consumption (1986-1990)*

Resource	**Industrialized Countries**	**Developing Countries**
Fossil Fuels (gJ/capita)	160.06	17.28
Aluminum (mTon/100 capita)	14.13	0.69
Copper (mTon/1000 capita)	8.06	0.48
Roundwood (m^3/capita)	1.29	0.48
Beef and Veal (kg/capita)	27.17	4.29
Cotton (kg/capita)	5.35	2.69

Source: World Resources, 1994-1995

However, it is at the global level where most of the debate lies. The North argues that developing countries contribute a significant share to damaging the global environment. Although on a per capita basis they emit less than one quarter the amount of greenhouse gases as the North, on an aggregate scale their levels are more similar (Boydon and Dovers, 1992). And as population expands, the demand for non-renewable resources such as coal, oil and metal ores is expected to rise. Furthermore, as demonstrated in Table 3, when their living standards improve and consumption per capita grows, their contribution will become increasingly significant. The North thus seeks that the South curtail its environment-damaging activities, while the South seeks the right to follow the same resource-intensive path to development that the North had enjoyed. This argument has been observed within the implementation of the Montreal Protocol as well as in the current discussion of global climate change.

As compelling as the issue of the global commons is in the North-South debate, we must not overlook the distinction made earlier between the environmental effects of consumption versus subsistence. Developing countries may or may not be correct in their belief that Northern consumption (that is, consumption related to both population and living standards) is responsible for much of the degradation of the global environment. However, trying to allocate the blame in this manner may not be the best solution for the problems that they are facing. The issues that are of direct concern to

the South, namely soil and water degradation, food availability, and urban conditions, result from their own magnitude of numbers and the struggle of a large fraction of their inhabitants to achieve even a subsistence level of consumption. This is not to say that Northern countries do not have a duty to assist their Southern brethren in mitigating these problems. It is to say that Southern problems must be addressed via Southern solutions.

Table 3. *Population growth and energy consumption by region - 1960-90*

Region	Percent of increased energy consumption due to increase in population	Percent of increased energy consumption due to rise in living standards	Energy consumption per capita 1960 (in billion joules)	Energy consumption per capita 1990 (in billion joules)
Africa	32	68	6	13
Asia	16	84	8	24
Europe	17	83	72	126
North America	90	10	-	-
Canada	-	-	164	301
United States	-	-	236	292
South America	39	61	16	29
World	46	54	38	57

Adapted from *World Without End*, Pearce et al., 1993.
1990 data from *Environmental Data Report 1993-94*, United Nations Environment Programme.

V. POLICY SUGGESTIONS

Because the relationship between population, environment, and development is such a complex one, policy recommendations must encompass several perspectives, at the macro or national level and at the micro or local level, as well as between Northern countries and Southern countries. Our policy suggestions are divided into four conceptual areas. The first two areas address the relationship described in the Ehrlich equation at the macro level, and the second two suggestions will act at the micro level.

A. Macro-level policies for Northern countries.

Although this paper has downplayed the importance of non-renewable resource depletion and global climate change as environmental problems, they are certainly of import to the world in the long run, and the developing world will contribute to their evolution. Furthermore, as long as we do not have the option of leaving the planet, the plight of the citizens of Southern countries will not escape the North, if for no other reason than the poverty-induced political instability in petroleum exporting countries.

Therefore, it is in the long-term interest of the North to turn its attention to contributing to the solution of the problems that we have discussed.

Northern countries do not have a population problem in the usual sense, i.e., they are not suffering from widespread poverty and massive local environmental degradation. However, they do have a very large effective population. For example, the rate of growth of population in the United States is currently of the order of 1 percent per year (World Bank, 1994), but in light of its per capita consumption, there are significant implications for world resource use. This is consistent with the Ehrlich equation. A look at the mathematics tells us that in a country with a high per capita consumption and low population, a marginal increase in population has a larger effect on the environment than does a similar increase in consumption. Therefore, even a modest slow in US population growth would certainly contribute towards a reduction in the scale of throughput. Achieving zero (or negative) population growth in Northern countries should hopefully be easier than in developing countries, since there already exists high levels of literacy and children do not play as large an economic role in the family.

Even if they focus on population growth, Northern countries should not neglect their levels of per capita consumption. The levels of consumption in these countries are unsustainable in that they lead to global environmental problems and that a large portion of the resources consumed originate in Southern countries. A reduction in consumption can, in fact, be advantageous to these countries if they are achieved by increases in efficiency. Goodland (1994) lists ways in which developed countries can save money by modifying certain aspects of their economies, e.g. increasing mass transportation, encouraging energy conservation through domestic heating efficiency, and shifting from capital-intensive to service industries.

Northern countries should go one step beyond modifying their own behavior and take active steps in assisting Southern countries in their quest for population stability and environmental sustainability. In addition to international development aid, it is critical that the North be generous with its intellectual property. Northern technologies must be regarded as international public goods since the environment is an indivisible global good. Thus global arrangements should recognize this and include mechanisms to subsidize their acquisition by developing countries that neither have the expertise nor the finance to invest in Research and Development. This argument extends to technological know-how in areas concerning other basic needs -- food, health, pharmaceutical, housing, and education.

B. Macro-level policies for Southern countries.

In keeping with the Ehrlich relationship, countries with high population and low levels of consumption should focus on their increasing levels of consumption. Whereas few people would suggest that the South abandon its ambitions of raising its living standards, it is possible to improve quality of life without increasing levels of consumption more than necessary. In some ways, this goal may prove easier to achieve in the South than the North, since in many cases it means only adding efficient social and technological systems, rather than having to replace old ones. In this instance, the South would do well to adopt renewable energy systems rather than ones based on fossil

fuel, and labor-intensive industries rather than capital-intensive ones. It should be emphasized that the South is not to be restricted from increasing its consumption. Affluence is, in many ways, tied to living standards, and often they cannot be separated.

The South, of course, must also enact effective population policies. Macroeconomic growth is necessary to eliminate poverty and to decrease private discount rates in the long term and to ensure that population stabilization is permanent. However, in the short run, far reaching socio-economic and political change is necessary to reduce birth rates to replacement levels. Historical evidence suggests that when individuals and families gain power because their rights are protected, particularly the rights to education, medical care (including contraception), old-age security, and access to income-producing resources, they no longer have to depend on their own families for survival (Frances Lappe and Norman Schurman, 1989).

As made clear at the 1994 International Conference on Population and Development in Cairo, ensuring the success of family planning programs requires complementary measures for raising the social, economic, and political status of women. At the same time, it is necessary to promote cost effective health care measures to secure further reductions in infant mortality rates (United Nations, 1994). This would ease the insecurity in families that compels them to have as many children as possible as a cushion against a high rate of child mortality. Family planning services must be made available universally at an affordable cost with particular stress on maternal health. In addition, all these activities, in turn, have to be integrated with efforts targeted at poverty alleviation. Any population policy, especially in a large country like India, should also take account of regional variations in socio-economic parameters.

Past population policies in developing countries have been guided by the view that the primary obstacle to reducing fertility is inadequate access to or the prohibitive costs of contraceptives. Their efforts have, therefore, been directed at removing these constraints. It is now accepted that making family planning available is not sufficient unless there is a demand for its use. The above suggestions should act to increase the desire for limiting family size. However, there is already a significant portion, approximately 20 percent, of childbearing age couples who have unmet needs for family planning. Meeting this need would require only $11 billion annually (Mink, 1993), and would enable us to stabilize world population level at about 10 billion. This figure is 2.5 billion lower than the base case projection and would cost only about $10 annually for each person in the developed world.

C. Breaking the links between population and environment

Population growth is not a problem in itself. It is only the impacts of an ever-expanding population on a finite natural environment and the impacts of the same degradation on fertility that cause concern. Short of finding an infinite supply of resources, the best way to address the population-environment problem is to break the link between the two. While we work at the long range solution of social and economic change, we can achieve more immediate relief by stopping vicious feedback cycles that we have seen between increased fertility and degradation.

1. Prevent environmental degradation from increasing fertility. When faced with the adversity of poverty and damage to their resource base, the poor find themselves with little control over their welfare. It is at times like this that they choose to turn to their seemingly only economic option: to increase their family capital by adding to its size.

Thus, the problem of high fertility stems from the demand for children. It would be beneficial, then, to construct policy measures that deflect this desire to have children as a result of adversity. Insofar as children serve as factors of household production, providing alternatives to poor households in the form of clean water and cheap fuel would preclude the need for children for menial household tasks like collecting firewood, dung, and water. A second reason for having children is for the old age insurance that they provide. If localities could provide ready access to credit and capital, it would increase the economic security for the poor in their old age and diminish the value of children as a form of insurance (Dasgupta, 1992).

2. Arrest the degradation of the environment from demographic pressure. Many types of environmental degradation are at least in part a result of demographic factors, i.e., when the poor are confronted with hunger and an apparently hopeless future, they revert to consuming their natural capital. Thus it would be valuable to identify solutions that would give the poor additional options.

Means to mitigate environmental degradation can be separated into two broad categories: incentives and institutions. Residents of developing countries often lack incentives for conservation, or worse, encounter incentives that encourage actions that are damaging to the environment. Local and central governments need to remove subsidies that lead to the rapid removal of groundwater, the clearing of forests for agricultural land and commercial timber, and the overuse of fertilizer and pesticides. They need to encourage infrastructure that facilitates access to clean drinking water and land appropriate for farming. Further, they should create property rights for the efficient use of resources and provide both formal and informal credit to help spread out risks. Lastly, they should stand ready with emergency aid in times of flooding, droughts, and other natural disasters.

In order to promote equality and efficiency and to provide assistance to the poor in the face of survival pressures, developing countries need to create new institutions. These might include a legal and judicial framework that settles land ownership disputes and enforces tenure systems. They might also include agricultural extension offices for the dissemination of information about agricultural and conservation practices; cooperatives for agricultural market power and risk sharing; and schools and hospitals to educate about resource management and to prevent some of the public health impacts from existing pollution. Finally, as Boserup emphasizes, a large population should not be overlooked as a human resources. Labor must be allowed to re-organize, and the Taylorian "labor surplus" must be eliminated.

The above policy recommendations do not address the larger social and economic factors that lead to the problems that we have examined. However, until those concerns

can be taken care of independently, these measures will break the downward spiral between fertility and degradation and prevent further impacts on the lives of those in developing countries.

VI. RESEARCH AGENDA

In addition to the above issues, there should be a conscious research agenda that addresses the following issues:

- The conflict between environmental considerations and development strategies. There is significant uncertainty as to the degree to which they are mutually exclusive. What is needed is an investigation of the factors that facilitate/impede the coevolution of environmental protection and development. As with the below discussion of Sub-Saharan Africa and Korea, the relationship may be best revealed through country and regional case studies which are location-specific.
- Means for changing consumption patterns in the North. Equally as important are consumption policies for those "Northern" regions that exist within Southern countries. As environmental problems are often global in nature, all such research should ideally be conducted as a joint effort between developing and developed countries.
- The limiting factor of development - environment or human capital. Since in many cases, developing country governments lack the financial resources to simultaneously undertake policies that address both the natural and human resource base, studies on this theme would give countries an indication of where best to focus their efforts. This also should be approached through country and regional case studies.
- Impact of industrialization on the rural poor. It is often assumed that development activities have unmitigated positive welfare effects. However, every development activity does have its negative aspects, and all such projects require research in the form of environmental impact assessments that look at the effects of industrialization on the social, economic, and environmental systems in those areas.
- Urbanization and its impact on the urban poor. Although, in many ways, cities provide amenities unavailable in rural areas, the poor in urban areas often experience little improvement in access to such infrastructure and services. It is necessary to make a critical examination of the status of the urban poor to see where gains can be best made in terms of preventing harm to the urban environment as well as mitigating the effects of environmental pollution on them.
- Evolution and development of environmentally friendly technology adapted to the poor. Although the Green Revolution may be three decades old, there is still much potential for technological advances that enable the poor to make more out of their limited resources and to subsist in ways that have minimal adverse impacts on both themselves and the environment.
- Training modules for scientists, policymakers, and non-governmental organizations that facilitate technological innovations and their adoption, adaptation, and management. In the end, all population and development policies will be implemented by individuals at the grassroots level. It is thus necessary to find the most effective way to utilize these individuals in achieving the desired ends, and to adopt policies that advance such programs.

ANNEXURE

The Case of Sub-Saharan Africa[1]

The interface of demographic forces, levels of development and the natural resource base is perhaps well brought out in the case of Sub-Saharan Africa. Demographic processes of high population growth, urbanization and migration have transformed the pace of development in the region and have deep implications in the years to come for the universal concerns of food security and the deterioration of the environmental resource base.

The African demographic explosion is characterized by a growth rate of 3 percent per annum caused primarily by medical progress unmatched by the equivalent progression of production technologies. The region has been experiencing a doubling of population every 20 to 30 years. Further, Sub-Saharan Africa contains about 35 million international migrants, of which around 4 million are refugees. Almost half the total population in Sub-Saharan Africa is below the age of 16. This imbalance of the age structure in rural areas is reinforced by migrations of young men in their 20s leaving behind villages with a large majority of children.

Not only is Africa the world's fastest growing region in terms of population, but also the poorest. The average income per capita in 1992 was $530 with a negative growth rate of .8 percent during 1980-1992. The poor of the region rely on the surrounding natural resource base, and follow short-term survival strategies; the consequent degradation of the resource base lowers productivity and increases their vulnerability to environmental disaster and ill-health.

Urbanization is rapidly transforming the nature of African development. Thirty years ago there was only one city with a population of more than 1 million; in 1990 there were eighteen. African cities have not been able to develop the basic environmental services to accommodate this addition to urban dwellers, which has resulted in a steady deterioration of the urban environment, particularly affecting the poor. Moreover, most of the urban population tends to be concentrated in the coastal zones, so that these areas experience a multitude of problems related to agriculture and fisheries, water management and infrastructure, urban and industrial development. Most governments do not have institutional mechanisms to deal with these complex issues.

In the next three decades, population growth, migration, and settlement are expected to change the face of Sub-Saharan Africa. By 2025, the population of Sub-Saharan Africa is expected to be over 1 billion. And by 2020, urban population is likely to exceed half the total population in the region. Future migration will intensify due to population growth and its uneven distribution. Urbanization and migration are likely to be mutually reinforcing in the continuous crowding of coastal areas, expanding the current coastal population from 20 percent to 40 percent by 2025. Population is likely to build up along the coasts of West and Central Africa from Senegal to Angola, in Southern

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[1] This section is drawn from World Bank, 1995 and Cleaver and Schreiber, 1994.

Africa, including South Africa and Mozambique and in the coasts of Eritrea, Somalia, and Djibouti.

These projections for demographic development have immediate implications for food requirements. When the population base was small, farming was largely pastoral and nomadic with land lying fallow for long periods of time. But with rise in population since the mid 60s, and disturbance in the balance between population and food, new land had to be brought under cultivation, most of which was marginally productive. Furthermore, soil erosion in pasture and range areas also contributed towards a decline in fertility. Agricultural technology, such as intensive crop cultivation was environmentally destructive. Deforestation was also aggravated due to a large dependence on wood for fuel and building purposes as well as due to a lack of regulation on commercial logging. Deforestation, in turn, aggravates soil erosion and degradation, and loss in biodiversity. These developments manifest themselves in declining in per capita consumption. In 1980, the forest cover in Sub-Saharan Africa was 679 million hectares, and now it is being depleted at the rate of 3.7 million hectares per year. As much as half of the farmland and 80 percent of its pasture and rangeland are now affected by erosion.

Starting from a current deficit, food production now needs to grow faster than population. Assuming a consumption growth rate of 3.3 percent p.a. the demand for food will triple from 1990 to 2025. If all the theoretically available cultivable land could be brought into production, this demand could be met. This assumption, however, is unrealistic because much of this land is inaccessible, competition with alternate uses (livestock production) is likely to intensify. Further, crop and animal pests limit the extension of agriculture and deforestation would have severe environmental implications. It is estimated that food supply could be increased by about 60 percent by 2025. Half of this increase is expected from intensification and the rest from expansion of land. The remainder of the total increase would come from adoption of more productive technologies, only some of which are currently known. It remains questionable as to what extent this increase can be met through improved technologies. The shortfalls that remain would translate into increased environmental pressure.

Meeting the food challenge would also depend upon overall economic growth. If per capita growth can reach 1.5 percent p.a., this implies an increase from $530 in 1992 to $828 30 years hence. Even if this growth is realized, poverty would still remain a major bottleneck in the region and constrain much of the population to short-term exploitation of the environment unless improved environmental policies are adopted.

In summary, although sub-Saharan Africa is a region wealthy in natural resources, it is experiencing a prolonged demographic transition marred by wide-scale poverty and environmental degradation. This may be a result of political stability in the region, which precluded economic growth during the period and forced the growing population to pursue more extreme measures to attain even a subsistence living. Thus, the challenges that this region faces in terms of the population-environment-development nexus are: a) feeding people through improved and sustainable technologies while maintaining natural capital in terms of production potential and biodiversity, b)

facilitating a demographic transition towards a more stable population and a more balanced age pyramid, c) guiding migration towards a better population distribution in relation to development potential while mitigating environmental cost, and d) making urbanization sustainable, building upon the positive aspects of market growth in cities while breaking the downward spiral of deteriorating living conditions.

The Case of South Korea[2]

Whereas sub-Saharan Africa represents an area that is best characterized by high population growth and low consumption, South Korea represents the exact opposite: low population growth and high levels of consumption. Because it has essentially completed its demographic transition, and without high degrees of poverty and damage to the environment, it is of interest to us.

The present population of Korea is about 45 million, a level which is expected to increase very little in coming decades. During the early 1960s, Korea entered the second stage of its demographic transition, and experienced declines in its mortality rate while fertility remained high. This did not last long, however, as the popular use of contraception beginning in the middle part of that decade brought the total fertility rate down from 6.1 children per woman to 4.1 for the period of 1970-1975, and finally to an estimated 1.6 in 1990. As recently as 1950, its population was 20 million, with an annual growth rate of 3.1 percent, but this growth declined very quickly, reaching the level of 1 percent between 1985 and 1990. This amazingly rapid transition took only 20 years.

At about the same time as the demographic transition, Korea experienced rapid economic growth and industrialization. Its new export-centered policy led to a growth in GNP of about 10 percent per year from the early 1960s to the present. Per capita income rose from $75 US in 1962 to $4040 US in 1988, and the growth was associated with a massive shift from an agriculture-based economy to one predominantly industrial. Over the same two decades the urban population grew from 5 percent of the nation to an expected 81 percent in 2000 and the portion of GDP from agriculture fell from 38 percent to 11 percent.

The phenomenal fall in fertility can be attributed to the voluntary use of contraceptives. Contraception utilization rose from 25 percent of couples in 1969 to 77 percent in 1988, largely as a result of government concern about population growth and its focus on family planning. In addition to this interest and the general awareness and enthusiasm of couples and their communities, there were several additional factors that facilitated the reduction in fertility from a decreased demand for children. First of all, there was no religious or cultural opposition to family planning. Korea is a culturally homogeneous country and does not have the ethical problems that some Christian countries, for example, might have. Second, Korea already had a rather high literacy rate, which made communication about family planning easy. Thirdly, Korea was experiencing economic

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[2] This section is drawn from Kim and van den Oever, 1992.

growth and high employment, which increased the opportunity cost for children and gave couples an economic option other than increasing their family size.

The modern, industrial Korea is not free from environmental damage. Its large growth in income and consumption has led to a sixfold increase in energy use, which in turn, was the cause of an annual increase in carbon dioxide emissions by 21 million tons. Besides this, Korea has seen vast growth in urban air pollution, industrial waste, and the depletion of its fisheries. Korea is now turning its attention to pollution control and resource conservation, but for many years it was categorically unconcerned about its environment. In fact, smokestacks were previously viewed as signs of economic strength and progress.

In summary, the demographic transition experienced by South Korea was vastly different from the one in sub-Saharan Africa. The transition was very rapid and relatively painless -- without the poverty and local environmental degradation being suffered in sub-Saharan Africa. The rapidity and the painlessness can both be attributed to South Korea's concurrent economic growth. The growth in GNP provided the financial resource for educational and public health infrastructure and the jobs and increasing living standard for its residents, and gave them incentives to reduce their fertility. At the same time, it provided for the increasing numbers and avoided the poverty which would have induced the populus to consume its natural resources. The pollution in South Korea is recent in nature, and is tied to high levels of consumption rather than population growth and poverty, and with its financial wherewithal, South Korea should be able to make swift advances in combating it.

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Population as a scale factor: Impacts on Environment and Development

Submitted by

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Population as a Scale Factor: Impacts on Environment and Development

Robert Engelman[1]

\bstract

Precise quantification of the impact of population growth on the environment and the development potential of nations may not be possible or even necessary for policymaking. This is especially true given the international consensus in support of universally-available family planning and reproductive health services and improved educational, economic and social opportunities for women. Achievement of these goals, worthy in their own right, is the only sure path to stabilized populations.

The interaction of population dynamics with other factors in the environment and development is complex. Population growth operates over long time periods and is much more than a multiplier in an equation. A better image may be a scale factor, steadily increasing the scope and stimulating the expansion of human activities—sometimes beyond critical natural thresholds.

Within developing countries, policymakers as well as scientists increasingly express concern about the future of natural resources critical to development, especially water supply, arable land and fisheries. Trends in these resources are closely related to the dynamics of population growth within the nations concerned. The emerging problem of human-induced climate change, by contrast, raises fundamental issues of equity and governance related to global population growth and consumption patterns and their impact on the environment and development prospects of poorer nations.

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Introduction and Background: Scientific Uncertainty and Policy Implications

The rapid expansion of human activities in recent decades is the decisive factor in the present alteration of natural resource bases that have been available to societies for millennia. Scholars and analysts have been unable to reach any agreement on the role population growth plays in this alteration. They differ substantially on the relative importance of simple human numbers, on the one hand, and, on the other, multiple aspects of human behavior, such as consumption patterns, political institutions, inequitable wealth distribution and technological change.[1]

In part this confusion stems from a lack of uniformity in dealing with the critical issue of time. The population growth of any given time period may have little impact on the use of a natural resource during the period of that growth. Yet the cumulative product of past growth may largely determine the scale of the resource use even after a population stabilizes. The current disproportionate share of the world's energy used by the United States, for example, owes more to the 3 percent annual population growth that country experienced in the 19th century than to the 1 percent annual growth it experiences today. One can add as well, of course, that the average American uses many times more commercial energy than the average resident of most developing countries. But this fact would be of only passing consequence had the United States population stabilized at its 1820 size of 9.6 million.[2] By the same reasoning, the environmental impacts of today's population growth in rapidly growing countries may not be fully evident until after these populations have stabilized, presumably at a time when development has advanced and per capita consumption is higher than it is today.

For a variety of reasons—especially the complexities and uncertainties inherent in human and physical systems—a precise quantification of the role of population dynamics in natural resource use and disposal is not possible. The pursuit of precision in this field is valuable in that it improves understanding and stimulates dialogue. If the discussion brings policymakers to a greater appreciation of the importance of population dynamics in environmental preservation and sustainable human development, so much the better. Yet the reality is that many policymakers are becoming more persuaded about population's importance by the realities they see within their own countries—growing conflicts over scarce water supplies, for example, or food production that fails to keep up with increasing demand—than by abstract scientific analysis and debate. The intricacies of the relationships may elude them, but they know there is an intimate connection between the size and change of their populations and the resource problems they must manage. Increasingly it is presidents, agricultural ministers, water planners and fisheries department directors who call attention to the unsustainability of their nations' population growth rates.

This reaction is an appropriate one. Despite the lack of scientific consensus on the nature of population's impacts on the environment and prospects for development, the implications

of the research for population policy are relatively straightforward. The ongoing growth of human population in most countries challenges efforts to improve human life and conserve the natural world on multiple fronts. The improvements that would have occurred in recent decades in food production and in the consumption of energy and water have been significantly undermined—and in some cases reversed—because population growth has worked in the opposite direction of the gains in per capita production and efficiency. This destructive pattern will be defused only when populations stabilize—or, more accurately, when population sizes alter only modestly and decline as much and as often as they increase.

If the most effective policies to slow population growth over long time periods were expensive or onerous—if they violated human rights, for example—an airtight scientific argument would clearly be needed that population was the "major cause" of environmental degradation. But this is not the case, so there is no such need. As 179 nations agreed in Cairo at the 1994 International Conference on Population and Development, the very policies that most directly improve the well-being of individuals worldwide—especially the well-being of women—are the ones most effective in slowing population and eventually bringing nations to stable population sizes. Among these policies is universal and affordable access to safe and voluntary family planning and related reproductive health services, so that all couples and women can have the childbirths they want to have, when they want to have them, in good health. The importance of family planning is demonstrated in the evidence that desired family size is falling dramatically around the world, even in Africa, while access to a choice of affordable and effective contraceptive techniques is spreading far more slowly. By some estimates, universal access to family planning services would result in a reduction of average fertility in developing countries halfway from the current levels of about four children per woman to "replacement value" of about two children per woman. This total fertility rate, if maintained, would result in stable populations within two or three generations.[3] How to move all the way to replacement fertility? An all-out societal effort to afford women and girls as many opportunities as men and boys in school, in employment, in business, in politics, in society as a whole would almost certainly result in average global fertility rates of two children per woman, or fewer, as has occurred in most of the world's industrialized countries.

Why go into this detail here? It is important to establish from the outset the correspondence between sound population policies and human development based on individual freedom. The misconception persists that scholars must prove beyond doubt that population growth is a major driver of environmental degradation and slowed economic development so that policymakers can justify difficult, controversial and expensive policies to restrain rampaging population growth. The overwhelming body of evidence and the global conversation that took place in Cairo is 1994 argue precisely the reverse: Enlightened population policies offer an easily affordable "no regrets" strategy that make sense even if population growth turned out to be a perpetually benign factor in environmental conservation

and economic development. Indeed, given the long time periods needed to reach stable populations, we can argue that coercion in population programs is not only unethical, it would not work, because couples and women eventually will rebel and thwart the efforts of demographically driven bureaucrats. Only a sincere and responsible response to the real and expressed needs of those of childbearing age for birth spacing and family-size limitation can promise the ongoing, long-term changes needed to ease world population growth to a gradual halt.

That said, we can begin to explore the difficult terrain of population dynamics and their impact on countries in the process of development.

The Current and Projected Future State of World Population

The planet is now home to 5.7 billion people, having gained more since 1950 than it had in all of time to that point. By one estimate, 105 billion human beings have lived on earth to date, but for the vast majority of the tens of thousands of years human beings have walked on earth, world population was in the low millions, not the low billions.[4]

Today four fifths of the world's population lives in developing countries. This paper will address primarily the most direct impacts of this population growth in the countries where the growth is occurring. Yet even this attempt to define the discussion is complicated by the difficulty of distinguishing local from remote population-environmental linkages. More than half of all the world's population growth, for example, is occurring in countries with tropical forests, such as Zaire, Brazil, Indonesia, the Philippines, Mexico and the nations of Central America. Discussing the ultimate and proximate causes of the loss of forests in these countries illustrates the perils of overly narrow views of what population growth is and where it is occurring. Various assessments have assigned the dominant responsibility in loss of forest cover either to "population growth"—usually defined as the growth of landless farmers on the perimeter of forests—or "logging" or other commercial resource extraction, including the spread of cattle ranches.

Properly speaking, however, all of these factors are linked to population growth occurring somewhere—the local growth to the inhabitants of the countries where the forests are found, the logging and cattle ranching to increasing global demand for tropical woods and beef. This growth clearly relates both to population and economic growth worldwide. In the first case, we can speak broadly about the local impacts of local population growth. In the second we must consider the more complex interactions between population growth and consumption patterns in far-flung foreign markets. Both are having an impact on the tropical forests, but we need to be precise about the differences.

Three United Nations projections suggest that world population in 2050 will be as low as 7.6 billion or as high as 9.8 billion, with 8.3 billion a medium figure.[5] These are *not*, however, predictions, but scenarios based on assumptions about future birth, death and

migration rates that may or may not be close to the reality. UN projections suggest future population size as far as 2150 (Figure 1), when human numbers could be either still growing rapidly (high projection), roughly stable (medium projection) at around 12 million, or declining gradually (low projection) based on low global average fertility rates.[6] These are, of course, global figures, and the impact within certain countries is far more dramatic. If we assume—inaccurately—that the medium UN projection is an "expected," or "most likely" scenario, we must then consider it "likely" or "expected" that Ethiopia will be home to 194 million people in 2050 (nearly four times its current population) and Pakistan will have 381 million people (nearly three times its current population). The impact of such populations on local resource bases, many of which already show evidence of stress and potential collapse, strains the imagination. The point here is that population projections are, in the words of Joel E. Cohen[7], "conditional predictions," dependent on a number of assumptions that may or not may prove valid. One such assumption is that population size can never reach a point where negative ecological and developmental feedbacks would lead to increases in death rates. This assumption is clearly in error, but because no one is certain how to correct it, it remains fundamental to most population projection. For this reason and others,[8] population projections should be used with the understanding that they are mathematical constructs that can provide an idea, rather than any certainty, about how population growth will proceed in future decades.

One population trend with special importance to the environment and development prospects of less-industrialized nations is urbanization, the subject of a major United Nations conference in Istanbul later this year. More than half of the world's inhabitants are projected to be living in urban areas by the year 2005. In Latin America, this halfway point between countryside and city was reached years ago. Especially significant is the growing concentration of population in dozens of "megacities" of 10 million or more.[9] This is a scale of urban agglomeration far beyond any the world has ever known.

At first glance, it may seem that urbanization will have environmental benefits by relieving population pressure in rapidly growing rural areas. But this benefit is an illusion. Population growth continues in most rural areas, albeit usually more slowly than in nearby urban areas. City dwellers have needs for food, fuel and materials that force the extension of supply networks into rural areas and even around the globe. As noted, the demands of wealthy urban dwellers for tropical woods and beef have contributed in past years to the destruction of rain forests. Moreover, the local environmental impacts of urban activities—air and water pollution, especially—can shorten human life and harm health. Since most megacities are on or near coasts, the world's population is also moving toward coastal areas, with inevitable impacts on fisheries and other coastal resources. Finally, the extreme and extended crowding that occurs in large, densely populated urban agglomerations adds substantially to the risk of outbreaks of infectious disease.

Population momentum, resulting from the bulge of young people now approaching or traversing their childbearing years, means that unless global catastrophe intervenes world population will continue to grow for some time. The force of population momentum can be reduced somewhat by policies that successfully encourage later marriages and greater spacing of childbirths. But unless birthrates go into an unexpected tailspin or death rates rise, or both, it is unrealistic to expect world population to stop growing before the year 2020.

Positive demographic trends include the growing desire for smaller families and personal regulation of fertility, and recent international consensus on the key elements of enlightened population policy. Both fertility and desired family size have been declining in most regions since the 1960s, and average fertility rates in developing countries have dropped from roughly six children per woman to fewer than four. More than half of all married couples in developing countries now use contraception, up from about 10 percent in 1960.[10] And this trend has recently become apparent even in some sub-Saharan countries, such as Kenya, Zimbabwe, Nigeria and Botswana.[11] As more people move to cities, seek education for their children and encounter electronic media and the consumer culture, the desire for large families often weakens quickly.

From the standpoint of government policy, the Cairo conference offers real hope that population issues will be addressed in the future out of a shared commitment to human development and individual freedom to determine the timing of childbearing. The United Nations-sponsored conference was historically unprecedented in achieving near international consensus for this strategy. The longstanding debate over the importance of contraception was resolved in favor of broad agreement that quality choices in family planning services should be universally available. So, too, should the educational and economic opportunities that allow women to make informed, effective and safe choices about when, with whom and how often to bear children in good health.

Surprisingly, almost 45 percent of the world's people now live in countries in which average fertility rates have reached or fallen below "replacement"—including almost all industrialized countries as well as China and some other developing countries in Asia. If fertility rates do not rebound significantly and if net immigration is not a significant demographic factor (as is the case in the United States, Canada and Australia and, today, even Russia), the populations of these countries will stabilize by the middle of the next century—and may then begin to decline gradually.

Nonetheless, uneven access to family planning and reproductive health care services worldwide still condemns many couples and individuals to unintended pregnancy and childbearing. And in the 18 months following the Cairo conference, it has become apparent that some countries are not prepared to honor their commitments made there. The United States government, for example, has recently slashed funding for international population assistance, forcing developing countries in need of assistance to look elsewhere for leadership.

While we cannot predict precisely how much of a problem future human population growth will present for environment and development in developing countries, we *can* state confidently that the actions governments take today in the population arena will influence profoundly the size and date at which human population will stabilize in the next 150 years or beyond.

Population-Environment Interactions

The existing population-environment research base tends to support the idea that human population itself—the number of human beings living in any unit of land—does not alter environments directly or in a linear fashion. Rather, population acts with and through such variables as social organization, government policy, dominant technology and personal consumption behavior. The connections are complex, indirect and variable by location and time scale. Often a rather long sequence of causation leads from population growth to changes in the environment, and this is true of the national impacts of national population dynamics.

In our work at Population Action International, we have found it useful to consider the changes in per capita availability of such key natural resources as renewable fresh water and arable land. Although these per capita figures are necessarily averages that do not reflect disparities in access to resources, they constitute an important first step in understanding population-natural resource linkages. Per capita availability establishes a background level of resource abundance or scarcity against which all politics, economics and inequities in power and wealth plays out. Moreover, per capita availability can be used as a kind of research "control." The concept helps analysts understand where nations would be absent the many factors that make for disparate access in real life. If societies ever approached the elimination of access inequalities and expanded access (the real capacity to use a resource) to the point that it approached availability (the theoretical capacity to use the resource), the per capita availability indicates what each resident would have to work with.

Here again, it is useful to consider the growth of human numbers not as a determinant of aggregate behavior but as an expansion of the scale or field of activity in which real women, men and children have real impacts on the environment. The scale of such activities and impacts tends to expand, while the scale of physical resources remains static or even declines. Being inventive, human beings typically develop new ways to use the resources more efficiently or imaginatively, but the scale imbalance—growing human activity against the backdrop of finite natural resource bases—remains. Absent continuously successful efforts to improve use efficiency or develop suitable substitutes for specific natural resources, population growth thus tends to push the scale of human activities to and beyond the points where collisions with natural resource limits occur.

Three Critical Natural Resources: Water, Cropland, Fish

This is anything but a theoretical formulation, as national and local policymakers the world over can attest. In country after country, wealthy as well as less wealthy, the supply of renewable fresh water is increasingly constraining the location and extent of settlement, agriculture, industry and related development.

Because renewable fresh water—that which is provided by the hydrological cycle as rain and snow falling on land—is finite, the amount of this water available to each person declines as population grows. Although renewable water must and can be used with much more efficiency, it is inevitable over the long term that population growth will result in increased human withdrawals from streams and rivers. At the point that a watershed becomes "closed"—that is when all water is withdrawn, used and "consumed" (either through evaporation or severe pollution)—the entry of any new user requires that other users withdraw less than previously. This ongoing parcelization or subdivision of finite water supplies can be particularly hazardous in the many watersheds that cross country borders. Nine countries, for example, share the waters of the Nile River basin with Egypt, which sees the source of 97 percent of its fresh water threatened by the development efforts upstream. At the population levels that existed until the last few decades, almost no development scenario could have threatened Egypt's security. Under the population levels of the Nile basin projected for the 21st century, by contrast, any significant upstream development would reduce the flow of the Nile, every drop of which Egypt will need to produce its food, cool its industrial machinery and keep its citizens healthy. This is a formula either for conflict or for energetic diplomacy, depending on the foresight of leaders in the Nile watershed.

Hydrologists use the benchmark of 1,000 cubic meters of renewable water per person per year as the upper boundary of water scarcity in a country, arguing that it is exceedingly difficult for a developing country to make the transition to full industrialization without this amount. A country may be able to base its development on nonrenewable water supplies (such as those offered by groundwater aquifers that filled in the ancient past but are no longer recharged effectively under current climatic conditions). But this is hazardous, as these aquifers eventually will become too depleted to use—perhaps at a time when both population and economic development have reached levels where the loss of dependable water supplies would threaten disaster. For the sustainability of societies, only renewable water should be depended upon, and its availability relates critically to population size and distribution.

We can quantify how many people are projected to live in countries with conditions of scarcity (with fewer than 1,000 cubic meters of water per person per year) or water stress (between 1,000 and about 1,700 cubic meters per person per year). Data for both population and total annual renewable water is available for 149 countries. As can be seen in Figure 2, not only the number but the proportion of people living in water-short countries will depend greatly on which trajectory of population growth the world follows in the coming century.[12]

The United Nations' 1994 medium population projection suggests that by the middle of the coming century, 4.4 billion of the nearly 10 billion people projected to inhabit the planet will live in 58 countries experiencing either water scarcity or water stress. Under the high projection, the proportion of the world's population living in 66 water-short nations would be 65 percent, or 7.7 billion out of a total world population of 11.9 billion people. Under the low projection, by contrast, the proportion would be 44 percent, or 3.5 billion people living in 51 water-short countries out of a total world population of 7.9 billion. Clearly, the extent of future water shortage will depend to a large degree on which trajectory population follows.

Mexico City offers a compelling example of the impact growing water scarcity can have on urban environmental quality and development prospects. Less than 1,000 years ago, the Aztec Indians settled a verdant group of islands connecting two mountain lakes. Today the lakes have long since disappeared under pavement, and the megacity is home to more than 15 million people. About 70 percent of their water is supplied by underground aquifers, the ongoing depletion of which is causing the city to settle and sink and is raising the risk of contamination by agricultural and industrial chemicals, which would be too expensive to clean up. Some water is drawn over mountain passes by pipeline, but this is expensive and few new sources of water are available as population continues to grow in the regions surrounding Mexico City. The city could recycle its water more effectively but apparently has no long term prospects for matching renewable water supply to the growing needs of its expanding populace.[13]

A similar relationship between population growth and per capita resource availability applies to the use of farmland, which most developing countries rely on domestically to produce the bulk of food consumed domestically. Unlike fresh water, food can be traded for in large quantities and transported long distances. Yet any country forced to rely on external sources of food either must produce some tradable good at least as valuable as food (tourism, in the case of some small countries) or must depend on the whims of international charity for food aid. Policymakers in most developing nations prefer to base policy on the assumption of rough self-sufficiency in food after imports and exports are accounted for.

The global area of arable land has grown in rough correspondence with human population since the dawn of agriculture—until the past few decades, that is, when the expansion of arable land slowed down. World population now grows at eight times the pace of total area of arable land—1.6 percent compared to 0.2 percent—which guarantees that the world's available arable land must be worked much more intensively to bridge the gap between the two rates.[14] As the agricultural frontier closes, land intensification is replacing land extensification.

Without special effort, this results in a depletion of soil-based carbon, which is the food on which depend vast and diverse populations of arthropods and microorganisms. There is very little research examining the dynamics of soil biodiversity, but there is increasing

evidence that a wealth of species helps cycle essential nutrients—essential either to plant or human health or both—between bedrock, soil and atmosphere. Some microorganisms protect food plants from pathogens and disease.[15] Moreover, as monoculture expands in farming areas, both food-related and associated biodiversity decline, often necessitating greater use of chemical pesticides. Loss of nutrients, resulting not only from topsoil loss but from the simple process of transporting crop material away from the soil on which it grow, requires increasing fertilizer use. This fertilizer will cost farmers money, and it may or may not make up for the ongoing loss of soil-based micronutrients. These may be critical not only for yield but for the health and disease resistance of the crop plant—not to mention the health and disease resistance of the human beings who ultimately consume the grains, fruits and vegetables.

Arable land, like renewable water, is a finite natural resource, so calculations can be made, similar to those on water availability, about the future of per capita arable land availability. No societies have managed to feed their populations with less than 0.07 hectares of arable land per person, unless they have used the kind of intensive, chemical-based agriculture common in the western Europe, Japan and the American Midwest. Based on this benchmark, if we assume that global arable land extent will remain constant at 1990 levels (it is not expected to grow by much and could easily decline), the rate of population growth over the next 150 years will determine whether 1.6 billion people, 5.5 billion or some number in between live in countries with scarcities of arable land in 2050 (Figure 3).

Obviously, technological innovation in agriculture has boosted yields in the past, and is likely to do so in the future. But we cannot depend on the past as a guide. Farmers are stressing limited cropland as never before in history, and intensification must not only continue but accelerate to keep up with population growth, economic growth and the drive to reduce malnutrition. Confidence that this task will be easy is unwarranted.

Most of the world's current population growth is occurring in countries—India, Pakistan, China, Mexico and Ethiopia, for example—that have almost no potential for adding to farmland. Indeed, these countries are actually losing cultivated land to the ubiquitous spread of factories, office buildings, shops, homes and highways. The food that will be required to feed a world population of 8 billion or more in the next century will have to come almost entirely from today's farmland. Yet much of that farmland is not only shrinking in area, but is drying up, taking on salt and toxic metals, or losing topsoil and the nutrients on which plant and human health depend. An area of land the size of China and India has lost productive potential, while 25 billion tons of topsoil wash off the land each year. With farmland, as with renewable fresh water, sound population policies are not an alternative but a supplement to the many steps needed to put resource use on a sustainable basis. Only when demand for food is roughly stable will the need to achieve food security and the need to conserve soil and water cease to be to some extent at odds.

The state of the world's fisheries provides similar evidence of a collision of human needs and natural resources that is occurring today. By the accounts of experts, the world's oceans and rivers are unlikely to be able to supply more than 60 million metric tons per year of fish as food for human consumption. This is actually slightly above levels at which the global fish catch has leveled off since about 1989. Aquaculture, growing rapidly, contributes roughly another 16 million tons today, and is likely to contribute more in the future. But how much more? Calculations by Population Action International, based on UN population projections and the assumption of constant global per capita consumption of fish as food, indicate that by the middle of the next century fish farmers would need to produce more food from fish than all the world's oceans and rivers now contribute from wild-caught fish under both the medium and high population projections. Only under the low population projection would wild-caught fish still dominate, with aquaculture contributing "only" 43 million tons of food (figure 4). Most fish experts are skeptical that aquaculture can go much beyond twice its current outputs, if that, because of limitations on and competition for suitable land for ponds and pens and dependable water supply and the growing challenge of keeping cultured fish in a state of reasonable health.[16]

The implications of this calculation for the people of developing countries are sobering. Until populations stabilize, the cost of fish is very likely to continue to rise, pricing the poor out of what historically has been among the few inexpensive sources of high-quality animal protein. Stabilizing population alone would not reverse the decline of fisheries, but as with other critical natural resources that are vulnerable to growing human demand, a combination of population and conservation strategies will be needed to allow fish to once again become a nutritious food that is available and affordable to all.

The convergence of north and south

Water, cropland and fisheries are three of the most obvious examples of critical natural resources placed at risk, once certain natural thresholds are approached or crossed, by national and local population growth . Although it is characteristic of both demographic and economic disciplines to separate the world's nations into two or three major groups, one cannot study these resources without being struck by the convergence of population-related resource problems in both the wealthier countries (the "North") and those in the process of development (the "South"). Water shortages and hazardous declines in water quality are experienced in many or most countries. Farmland suffers soil erosion and nutrient loss and is converted to other uses in almost all countries. Fisheries are declining worldwide.

The long-repeated idea that environmental damage worldwide is caused predominantly by the wealthiest 1 billion people in the world and the poorest 1 billion is an oversimplification of the reality. All people, at all levels of incomes, have environmental impacts which vary by income level as well as by cultural, technological and even individual

human differences. The dramatic increase in the middle class within developing countries and the onward march of globalized trade and globalized culture is demonstrating the wide range of stresses large populations of all income levels have on local environments and governments' capacities to manage environmental change while trying to encourage economic and social development. The immense problems Mexico City faces with air pollution, for example, demonstrate the complexity of linkages of population, consumption and the environment. Is this a population problem? A consumption problem? A technological problem? A policy problem? A problem related to wealth? To poverty? It is all these and more—as are most environmental problems with which policymakers must deal.

Perhaps the most difficult of these problem is the emerging challenge of stabilizing the planet's atmosphere. The scientific consensus has clarified in the past few months that humanity is not only raising the atmosphere's capacity to trap solar heat near the surface of the earth, but that this increased capacity is almost certainly contributing to climate change that is occurring today. This raises fundamental questions of international governance and equity. The nations and individuals that are contributing the most to the accumulating risk of human-induced climate change are precisely those most capable of adapting to the impacts of that change. Those nations and individuals contributing the least to the buildup of greenhouse gases in the atmosphere, by contrast, tend to have the least capacity for dealing with the predicted impacts of increased drought, increased flooding, sea-level rise and alterations in patterns of infectious disease. In the middle are a broad range of countries that contribute modestly to climate change and have some capacity to deal with the problems it may cause.

Clearly, the climate problem is global and the solutions will need to be global as well. Equally clearly, population growth in wealthy as well as less wealthy countries is complicating the challenge of finding equitable ways to scale back the use of fossil fuels and other natural resources that contribute to the buildup of carbon dioxide and greenhouse gases. From the standpoint of equity, those countries that are "climate sustainable" (not, on a per capita basis, contributing more greenhouse gases to the atmosphere than can be absorbed by the natural recycling of these gases) have a right to argue that they deserve assistance—indeed compensation—from those countries that are contributing to the growing risk of hazardous, human-induced climate change.

Yet it is also the case that every country has a stake in encouraging population stabilization in all countries, since all human beings logically have an equal right to use the atmosphere for the disposal of greenhouse gases resulting from the activities of daily life. The higher the world's population climbs after nations become serious about stabilizing atmospheric concentrations of greenhouse gases, the smaller the allowable per capita emissions of such gases and the more pressure will be exerted on individual atmospheric disposal rights. One could argue, as some have, that it will be up to the world's wealthy

countries to resolve climate issues. But world population could reach a point, under some projections, where even "survival emissions" in a world without wealthy countries would be sufficient to elevate concentrations of greenhouse gases and augment climate change.[17]

Responsibility and the capacity to respond

As the examples of population-environment linkages indicate, once key natural thresholds are approached or crossed, population growth tends to limit the possibilities for effective response to resource scarcity. Governments are often forced into "lose-lose" policy choices because no available option can quickly restore a natural resource base or environmental condition to its previous state—not, certainly, without trampling on legitimate interests. Ultimately, the need for near-miraculous policy solutions to natural resource constraints on development will be reduced, and the effects of good policies and programs can only be enduring, if population itself is addressed as a critical factor within a matrix of other critical factors.

Fortunately, policymakers have already reached a global consensus on the kinds of policies most effective and most needed to slow the growth of world population. The representatives of national governments who attended the Cairo conference on population stressed the basic human right to regulate one's own reproduction. The Cairo agreement recognized that these services enabling couples, and especially women, to do this in good health should be voluntary and should offer a range of safe and effective contraceptive options. And they should be available and affordable to all who need them. Where possible, they should be provided in the context of services that include a broader range of maternal and child health care as well as reproductive health care services.

Distressingly, the United States government recently decided to abandon leadership in working with developing nations on the provision of critical family planning and reproductive health services. As a result of efforts by some in the U.S. Congress to equate family planning and contraception with abortion, the money the United States will spend on international assistance in this area will be only 14 percent—literally less than one seventh—as much in fiscal year 1996 as was spent in 1995. Moreover, no U.S. money can be committed to family planning programs abroad until after July 1. The effects of this reversal are likely to be disruptive and possibly shattering to the health of women of childbearing age and their children, and it can only harm efforts to slow population growth in developing countries based on the childbearing desires of women and couples. For at least the foreseeable future, it will require political will among other population-program donors and the governments and non-governmental sectors of developing countries themselves to continue and expand the work already begun to achieve universal access to quality voluntary family planning services.

The survival of children also contributes over the long term to an easing of population growth rates—despite the fact that the initial influence may for obvious reasons be in the direction of higher population growth. There are two important aspects, however, beyond the

obvious ethical ones, of enabling infants and children to survive to their own reproductive years. One is that when first and second pregnancies are successful and children survive their early years, parents are much less likely to insist on multiple pregnancies beyond the number of children they ultimately want in their families. The other aspect is that one of the most important health interventions in aiding child survival is the use of contraceptives, which enables women to delay births beyond adolescence and then to space births at least two years apart. By attenuating each woman's reproduction (and men's, too, on average), postponement of first childbearing and the spacing of subsequent pregnancies can have an impressive impact on birth and population growth rates—as well as on the health and lives of women and children—even if they had no impact on fertility.[18] This adds to the arguments for universal access to voluntary family planning services.

As the Cairo conferees also agreed, it is also critical to provide girls and young women with at least the same schooling that boys and young men receive. Educated young women are far less likely than adolescents to become pregnant, less likely to have large families and more likely to use contraception. Moreover, they are more likely to make a contribution to their societies and economies beyond that of motherhood. Ultimately, the synergistic effect of access to family planning, education and economic opportunities is so powerful it is quite likely that something like the UN's low population projection could be achieved if all three could be provided to all the world's women. The low population trajectory would be the product not of successful "population control" or of global demographic targets, but of the collective actions of hundreds of millions of men and women with the capacity to make and put into effect their own decisions about childbearing.

The effect of such policies—while immediate in the lives of women, couples and communities—will be modest in the near term in slowing population growth within most developing countries. Over several decades, however, the impact of sound population policies will help determine the development prospects for nations on all the major continents. The stabilization of human population size will mark the dawn of an era in which problems of environmental conservation and economic development no longer pull governments in conflicting directions or accelerate toward disaster even as societies work to resolve them.

Population policies centered on human development and individual freedom would merit support even if they had no impact on population growth rates, because they improve well-being in multiple ways that have nothing to do with demographic change. Such policies are all the more urgent because of the close interdependence among human population dynamics and the integrity of natural resources critical to prosperity, health and survival itself.

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Effects of Population Pressure and Poverty on Biodiversity Conservation in the Philippines

Submitted by
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EFFECTS OF POPULATION PRESSURE AND POVERTY ON BIODIVERSITY CONSERVATION IN THE PHILIPPINES*

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I. INTRODUCTION

It is widely recognized that poverty and population growth contribute to environmental degradation, yet the linkages are insufficiently analyzed and documented (UNFPA 1991; Shaw 1989; Repetto 1987). As some studies (Cruz et al. 1992; Bilsborrow and DeLargy 1990; Malingreau and Tucker 1988; Repetto and Holmes 1983) point out, poverty-related factors are also population variables, and over time, both place unsustainable burdens on the environment. However, few have looked at precisely how they are interconnected within a particular country setting.

The need to understand the relationship between population and environment, both direct and indirect, and both proximate and ultimate, is especially significant for the poorest of the poor. Whether perceived correctly or not, the poor are seen as causing environmental degradation, particularly in the forest areas of many developing countries (Myers 1991; Bilsborrow 1987). Traditional and indigenous systems of resource use, which have been found to be sustainable at low population densities, are differentiated from the growing number of poor migrants who cultivate forest lands in order to meet short-term livelihood needs. Further, it is the bottom 30 percent poor households who have the highest fertility rates and the least access to information on family planning, education, and social services (UNFPA, 1991).

This paper focuses on one aspect of poverty and population: <u>the increasing number of rural migrants in search of alternative incomes and livelihood</u>. Because employment opportunities are generally limited in the urban centers of many developing countries, coupled with overcrowding and deteriorating facilities, the expectation of pulling migrants into cities has given way to a pattern of rural-to-rural movements, mostly to unoccupied and open forest lands.

This paper also looks at one form of environmental degradation: the conversion of forest lands into unsustainable uses. The most critical effect is the loss of biological diversity due to a decline in habitat and species endemism.[1] Although most of deforestation can be attributed to excessive logging, the activity by itself does not always lead to a permanent change in land use. It is the occupation of logged-over lands, and its use for agriculture by increasing numbers of rural migrants that, together with logging, has created in many developing countries a pattern of significant forest and biodiversity loss.

Using time series and cross-section information on the Philippines, this paper demonstrates how natural resource management policies, land tenure laws, rapid population increases, and economic policies have contributed to poverty-induced environmental stress. Part II describes the pattern of forest biodiversity decline. The growth of upland population and rural-to-rural migration is discussed in Part III, indicating the symmetry between destination regions and critical forest habitats. Part IV talks about some of the key factors influencing rural movements. Work done by Cruz, Francisco, and Amacher (1996), using an econometric model linking economic, environmental, and demographic factors to migration-induced deforestation, is cited to demonstrate the inter-related effects of economywide and sectoral policies on the environment. Lastly, Part V summarizes the key findings and offers recommendations for research and policy.

II. DECLINE IN FOREST BIODIVERSITY IN THE PHILIPPINES

The Philippines has, within its 300,000 square kilometers national territory, an unusual assemblage of terrestial and marine species, including some 12,000 plant species of which 3,800 are endemic to the country, 170,000 species of fauna, and approximately 500 species of coral (GEF/World Bank 1994). More than one-half of total area in the country is forest, which contains about 3,500 endemic tree and plant species. Most forest lands lie within jurisdictions of approximately 64 government-managed national protected areas (parks, wildlife sanctuaries, reserves). However, because of lack of resources, personnel, and financing, forests still remain virtually unprotected from encroaching hunters, traders, and migrants.

The Protected Areas System

The Philippine government has adopted the nationwide program, the National Integrated Protected Area System (NIPAS), to conserve sites rich in biodiversity.[2] The NIPAS divides the country's land and water resources into 15 bio-geographic zones, all of which are recognized as areas of high biodiversity and endemism by the World Conservation Union (IUCN). The map showing these zones is taken from the project document of the Global Environment Facility (GEF) and the World Bank-financed *Philippines Conservation of Priority Protected Areas Project* (April, 1994).[3]

The high concentration of biologically rich forests and wetlands in the country comes from its geomorphological history. Large land masses, constituting the country's major island groupings, were previously connected to the Asian mainland and Borneo during the Pleistocene era. This explains the existence of five large and distinct faunal characteristics and the highest endemism among countries in the region. In addition, forests are particularly dense and diverse due to varying exposures to shifting tradewinds and seasonal typhoons, mountainous terrain of varying heights and elevation, and peculiar patterns of rainfall (GEF/World Bank 1994).

Although not yet completed for the entire country, initial results of biological assessments indicate the severe and critical decline in forest habitat for more than one-third of identified endemic species. Previously dense hardwood trees, mostly old-growth dipterocarp forests, used to cover about 100,000 square kilometers during the 1950s, but by the early 1980s, forest area declined to just 20,000 square kilometers (World Bank 1989). The 1988 satellite-based national land use survey found that less than 10,000 square kilometers of old-growth forests remained, concentrated mostly in the bio-geographic zones in the northern part of the country (SSC 1988). Although there are still 30,000 to 40,000 square kilometers of disturbed or second-growth forests left, these are under threat from small-scale illegal loggers, shifting cultivators, and rural migrants. If these threats are unchecked, it is estimated that forest cover may not last until the end of the century.

Deforestation Rates

Because of the absence of reliable data on deforestation rates, the estimates of forest loss have ranged from 850 to 2,100 square kilometers per year. At either extreme, this is still one of the highest in the region. The lower estimate is from the Philippines Bureau of Forest Development for the period 1970 to 1985 (DENR 1988). This is based upon cadastral surveys and records submitted by district logging concessions and timber traders where under-reporting is often the practice to avoid payment of concession licenses and fees (Vitug 1993). The latter estimate of 2,100 hectares per year compares the government land use survey (for the 1970 baseline, see Gulmatico 1988) with more recent satellite information (NRAP 1991). Forest cover declined from more than 34 percent of land area in 1970 to 24 percent in 1988. Because the land use information do not come from the same sources, patterns of change need to be cross-checked with data on cultivated area. For example, during the 1980s, decline in forest area coincided with growth of extensively cultivated land in high elevation and hilly plantations and grasslands (NEDA 1987, 1990). Extensive agriculture occurred largely in previously logged-over lands.

As shown in Table 1, all types of forests comprise just 24 percent of total land area while extensive cultivation accounts for about 40 percent, and traditional and intensively cultivated agricultural lands cover less than 33 percent (SSC 1988). About two-thirds of remaining forests are lowland evergreens lying between 200 to 800 meters above sea level and which are dominated by dipterocarp tree species and broad leaf second growth forest and cogon (*Imperata cylindrica*) or talahib (*Saccharum spontaneum*) grasslands. The remaining areas are pine and mossy forests at higher elevations, from 800 to 1,500 meters or more in the northern and midwestern sections of the country. These forests contain the endemic species of mosses, leafy liverworts, filmy ferns, orchids, vines, *Podocarpus*, oak, *Symplocos*, *Tristania*, *Eugenia*, *Dacrydium*, and *Myrica* (GEF/World Bank 1994).

Due to rapid forest habitat destruction, 60 percent of endemic Philippine flora are now extinct, and some 57 species of mammals, birds, and reptiles are on the list of endangered species (WCMC 1992). Two endemic species of cultural and historical importance in the country are about to be extinct -- the tamaraw (*Bubalus minorensis*) and

the national cultural symbol, the Philippine eagle (*Pithecophaga jefferyi*). Although some of these threatened flora and fauna are maintained in sanctuaries, these parks have been degraded in many ways by human encroachments and hunting (see Table 2).

Occupation of Forests

Most forests are located in officially classified forest land (or uplands) while most of other land uses, such as intensive cultivation and urban areas, are in the lowlands. The Philippine government distinguishes upland and lowland by slope -- 18 percent (or about 10 degrees) and above slopes are considered the uplands and forest lands under government or state control; the rest are lowlands or alienable and disposable (A&D) lands which can be privately owned. However, such land classification is not strictly enforced. The Philippines Land Management Bureau (LMB) estimates that as much as 28 percent of forest lands are in slopes less than 18 percent, and about 35 percent of classified A&D lands have slopes in excess of 18 percent (DENR 1985). Furthermore, the LMB reports that, in 1981, about 13 percent of productive forests and 21 percent of old-growth forests were in A&D lands and 29 percent of permanent croplands were found in officially classified forest lands.

The lack of enforcement of land classification criteria, and the absence of comprehensive land cadastrals and forest surveys, have only served to heighten land conflicts over forests. Laws and administrative procedures remain unclear regarding ownership of forest lands which have been, inadvertently or not, classified as A&D lands. Among these privately owned forests are large-scale timber concessions (Vitug 1993).

A large and growing area of forests are occupied, most of them illegally, by rural migrants. Between 1970 to 1980, the population growth rate in timber concession areas was 3.5 percent per year, which was almost twice the national growth rate for that period (Cruz et al. 1988). In order to recognize occupancy rights of migrants, and to encourage conservation farming in hilly slopes, the Philippine government established in 1983 the Integrated Social Forestry Program. Under this program, Certificates of Stewarship were awarded to farmers covering an average of 2.5 hectares over 25 years on a yearly renewable basis (DENR 1990). In 1987, the government expanded the program and introduced two other arrangements. One was the Forest Land Management Agreement, which gave 25 year leases to villages to

protect forests. The other program, the Community Forest Management Agreement, awarded use rights to an individual or community for tree planting and maintenance. However, because these programs were aimed at tree planting and had minimal impacts on clarifying property rights, encroachments into unprotected forests continued to increase.

About 15 percent of forests which are largely uninhabited lie in higher elevation areas where biodiversity remains almost intact. Still largely virgin forest and undeveloped, these are less attractive for logging due to their remoteness and are unpopular among rural migrants who prefer the more accessible logged-over or semi-cleared sites. These pockets of forests have become the only refuge for what the Philippine government refers to as indigenous cultural communities (or ICCs). These ICCs are indigenous peoples with distinct cultural traditions and practices, including religion, language, and political decision making systems which are different from the dominant population. Under Philippine law, the ICCs have customary rights to forests. Although now recognized by the Constitution, these rights still need to be clarified by law and administrative procedure (Lynch and Talbott 1995).

Protected Areas

The Philippine government has yet to complete the national survey of biodiversity resources in forest and coastal areas. Under the NIPAS, an initial list of 64 protected areas, or roughly 80 percent of potentially rich biodiversity sites, have been declared as national parks, sanctuaries, or reserves (NEDA 1990; DENR 1990). Protected area boundaries, especially in parks and reserves declared prior to 1980, are defined through land cadastral surveys, but more recent satellite information have re-drawn these boundaries to coincide with major ecological characteristics (e.g., extent of species habitat and density). Once the boundaries are delineated (or "gazetted"), the protected area falls under government control regardless of the presence of human settlements inside the area.

The threats of encroachments into protected forests have become critical, considering that there are less than 7,000 square kilometers of remaining tropical moist forest in the country and only 22 percent of these have closed canopy cover (see Table 3). In addition, while more than 60 percent of the closed canopy, dense forests have been declared as parks or nature reserves, some 620 square kilometers of forests remain open and unprotected.

III. POPULATION GROWTH AND RURAL-TO-RURAL MIGRATION

Rapid population growth, lack of access to lowland arable land, inequitable land distribution and landlessness, and worsening poverty create pressures for migration. Although urban migrants still comprise the majority of internal migration in the Philippines, the rated of growth of urban migration has decreased due to growing unemployment in industry and urban services and a general decline in the economy. In contrast, migration towards frontier forest sites, which can be opened up for cultivation, has tripled in size since the 1960s. As a result, more than 17.4 million people, one third of total Philippine population, now live in the uplands, of which close to 12 million are farming in forest lands. If left unchecked at its current growth rate of over three percent per year, the upland population will double its current size by 2020.

Population Growth Trends

The Philippines has one of the highest annual population growth rates in the region. Although the rate of growth has decreased in recent years, the population projections still reflect substantial increases in population due to a slower decline in fertility (UN 1991). At an estimated two percent per year increase between 1988 and 2000, another 28 million people may be added to the current population of 63 million before the demographic transition to low birth and death rates occurs sometime in 2015 and 2020 (Bulatao et al. 1990).

There is a long history of high population growth rates. Between 1950 and 1985, population grew by 2.8 percent per year, and by 1985 to 1990, it was still close to 2.5 percent (UN 1990). Considering its land base, the population density increased from about 190 persons per square kilometer during the latter 1980s to more than 210 in 1990 (NSO 1990). It is thus among the most densely populated countries in the world. In addition, because one-half of total land area is classified as forest, large numbers of people are already residing in forests. Further movements into the remaining five percent of land under primary forest are

expected as the demand for cultivable land and fuelwood expand with the growing population.

Furthermore, movements into forests will continue to rise as the number of poor people increase. Over one-half of current population is below the poverty line and with standards of living below subsistence. The 1983 National Demographic Survey indicates that rural women, on average, have almost twice as many children as their counterparts in urban centers. Regions with higher incomes have much lower registered births, with poor regions having 5.3 children per woman compared to the better off regions with 4.7 (De Guzman 1987).

Large increases in working-age population and the high child dependency burden will continue to exert pressure on the country's resources and economy. During the 1990s, the economy must generate about 4.4 million new jobs each year just to employ the young population who will enter the labor force in the next 10 to 20 years (Nguiangain 1986). Between 1990 and 2015, for example, the working-age population is projected to increase from 35.3 million to 65.6 million (UN 1990; NEDA 1989).

Forest and Upland Population

The method of population census-taking in the Philippines, as in most other countries, gathers data by political and administrative boundaries. This poses difficulties for measuring forest and upland population. However, by using cadastral surveys and low-flying aerial photographs, the closest approximation of the census enumeration unit that corresponds to forest land boundaries can be applied in estimating forest population. There are 709 municipalities classified as upland or forest, representing 47 percent of all municipalities and more than one-half of the country's land area (Cruz et al. 1988).

The figures in Table 4 make use of the adjusted census boundaries and cross-checked with government statistics on classified forest and timber areas. Forest population has increased rapidly from 5.8 million in 1950 to almost 17.5 million by 1990. The annual growth rate, on the average, is close to 3:2 percent per year between 1950 to 1990, and 3.4 percent in the past decade alone (Cruz et al. 1992). If present trends continue, the upland population may increase by approximately one million persons each year in the next decade.

The upland population has grown much more rapidly than the national population because of increasing in-migration from rural areas as well as higher fertility rates. About 38 percent of all inter-regional migrants moved from over-crowded or low productivity agricultural regions to the less densely populated and more fertile irrigated areas throughout the 1960s (Fleiger 1976). It was during the 1970s that urbanward movements intensified while frontierward migration decreased. However, by the 1980s, migrants accounted for 14.5 percent of total upland population.

Upland population densities were relatively low during the early periods of in-migration throughout the 1960s. But with rapid population increases, many upland sites in the 1970s already registered densities of over 300 persons per square kilometer. The average density in lands with less steep slopes is higher, 260 persons per square kilometer, compared to the moderate and steep lands.

Forests in steeply sloping lands have experienced high rates of deforestation and soil loss. For example, in the upstream sections of one of the country's largest reservoirs, the Magat watershed, erosion losses averaged less than two tons per hectare for lands under forest cover but increased to between 122 and 210 tons per hectare in the upstream lands occupied by migrants engaging in unsustainable grazing and upland farming (David 1988).[4]

Upland Migration Patterns

Together with urbanization, inter-regional, rural-to-rural migration is a dominant factor in the distribution of population in the Philippines (de Guzman 1987). Although in-migration to cities continues to increase, resulting in uneven concentration in urban centers, large and growing numbers of migrants are also moving into agricultural and forest lands. Some of these movements are motivated by government programs, such as the planned settlement schemes during the 1960s (Paderanga 1988).

With the exception of the years between 1970 and 1975, the number of net upland migrants continued to increase throughout the four census periods. Between 1980 and 1990, upland migrants grew to almost three times the number who migrated between 1960 and 1970. Between 1980 and 1990, there were more than 3.5 million net upland migrants, accounting for 40 percent of all inter-regional migration during that period. It was also

during this period that the number of upland-to-upland movements increased dramatically, from less than six percent during the 1960s and 1970s to more than 38 percent of migration during the 1980s.

This pattern of lowland-to-upland and upland-to-upland movements is correlated with the rise in logged-over areas and mines. As Fleiger (1985: 138) explains: " logging camps and mines are usually surrounded by open, cultivable lands and offer to the families living there the possibility of augmenting farm incomes ... logging and mining do not require the skills which industrial jobs available in and around Manila demand."

Consequences of Increasing Migrant Encroachments

Expanded Cultivation in Forests. By the mid-1970s, the agricultural frontier in the lowlands was already closed, or near the physical and economic limits for intensified lowland cultivation. Together with unequal land distribution, landlessness, and deepening poverty in the rural areas, the movements toward open, uncultivated uplands increased. The expansion of farming in forests, especially in moderate to steeply sloping lands, required adoption of conservation practices to reduce soil losses. However, most migrant farmers were unfamiliar with such techniques.

Cultivated upland forest lands accounted for less than 10 percent of total cultivated area in 1960, compared to over 30 percent in 1987. As shown in Figure 1, cultivated area in forest increased from 5,820 square kilometers in 1960 to more than 30,900 square kilometers in 1987. Between 1980 and 1987, total cultivated area in forests grew by 2,700 square kilometers, or a rate of growth of 7.6 percent per year. Close to 60 percent of the increase in upland farming (some 1,600 square kilometers) occurred in logged-over lands with slopes between 18 and 30 percent, degraded grasslands, and shrublands which were unsuitable for cultivation (World Bank 1989).

The pressures to increase food production are high. The country needs to expand cultivation by 3,000 to 5,000 square kilometers a year in order to accomodate food requirements of increases in national population during the 1990s (FAO 1984). This means that with the closed lowland frontier, agricultural expansion will occur in lands that are in, or near, forest reserves with thin and highly erodable soils.

Increased Fuelwood Consumption. Large populations continue to rely on fuelwood for cooking, charcoal making, tobacco curing, and other household industries. The total consumption of fuelwood in 1985 was estimated at 28.5 million cubic meters (DENR 1988); roughly equivalent to the volume of wood lost from deforestation (Cruz and Repetto 1992). In contrast, reported commercial timber harvests during the same year accounted for only 3.6 million cubic meters.

More than 80 percent of cut fuelwood are for household uses. Upland households rely entirely on fuelwood for cooking; and in the the rural areas, 90 percent of households, and about one-half of urban households, rely on charcoal and wood for cooking (Tesoro et al. 1989). Around one-fifth of fuelwood supply comes from family woodlots or backyards; the rest, from nearby forests.

Fuelwood usage and demand will likely increase in the future, not only because the population is growing but also because of the high price of kerosene and natural gas. The 2.5 percent per year growth in fuelwood consumption during the 1970s increased to more than 4.1 percent per year between 1980 and 1985 (FDC 1987). By 2000, more than 55 million cubic meters of fuelwood will be consumed yearly; of which 80 percent will be supplied from forests (Tesoro et al. 1989). Yet, the total remaining volume of timber in 1987 was estimated at only 903.8 million cubic meters (Cruz and Repetto 1992).

Biodiversity Loss. As shown in Table 5, close to 1.2 million people reside within the boundaries of 50 out the 64 protected areas identified by the NIPAS. According to the population census, the number of people inside these areas increased at an average of 2.4 percent per year between 1980 and 1990. Some sites have grown tremendously due to tourism, proximity to market centers and towns, small-scale logging, and fuelwood cutting, with average annual growth rates in excess of three percent per year (e.g., Mt. Arayat, Bicol National Park, Mt. Makiling).

There are small patches of primary forests which contain some original vegetation and thus harbor the country's most important biodiversity species. For example, the ten priority protected areas included in the GEF/World Bank project have the country's largest collections of native and endemic flora and fauna, and still maintain relatively low density populations (see Table 6). There are more than 142,000 people occupying about 5,000 square kilometers land area. The population growth rate is modest at 1.8 percent per year between

1980 and 1990. Four of these areas constitute ancestral lands of indigenous peoples whose populations have remained fairly stable over the years.

However, while human settlements have not grown appreciably inside these protected areas, in the buffer zone, which includes municipalities adjacent to the boundaries, population has been increasing at an average of 2.5 percent per year. Although not everyone in the buffer municipalities exploit resources inside the protected area, the numbers show the potential pressures that can arise from population densities that are substantially larger and growing (see Table 6). And because more than 75 percent of people in these areas are migrants (or born elsewhere), it is expected that the bulk of future pressures will come from new migrants opening up lands for cultivation.

There will also be pressures from the existing buffer area population. For example, results of a socio-economic survey in the vicinity of Mt. Canlaon National Park (three municipalities; 230 households) indicate that the major occupation is cultivation of upland rice and coconut, followed by charcoal making and selling of firewood (IAST 1990). More than 83 percent of households surveyed derive about one-half of income from fuelwood cutting in nearby forests, some of which are inside park boundaries.

IV. FACTORS INFLUENCING PATTERNS OF FOREST MIGRATION

The descriptions of changes in population, poverty, and forest land uses over a long time period, from 1950 to 1990, and over a cross-section of the country, establish the direction in which these processes are likely to take in the future. For example, because population growth and poverty create strong incentives for moving into forests, there will be pressures for expanding cultivation into forest lands, increasing consumption of fuelwood, and occupying forest lands without clearly defined property rights.

However, such a descriptive analysis is often insufficient for policy making, especially if the interactive effects among these processes remain largely unknown. More rigorous analysis is needed in the design of relevant macroeconomic and sectoral policies. Such analysis will be useful in predicting the impacts, for example, of a population reduction policy in the rural areas in terms of lower deforestation rates.

Analytical Model of Forest Migration

The discussion of a model to determine the factors which motivate people to move out of rural origins and to settle in forests is based upon econometric work done by Cruz, Francisco and Amacher (1996). This econometric model, using a multinomial discrete choice framework, accomodates the many choices facing a potential migrant. It recognizes that an individual migrant faces various potential destinations. The decision to move is affected by a complex set of potential gains.[5]

The model makes use of data from three sources: (a) migration information based on place of birth and place of residence in 1985 contained in the 1990 Philippine census; (b) socio-economic data from various government series; and (c) a socio-economic survey of lowland and upland communities (IAST 1990).[6] Based on these various sources, it was possible to analyze migration streams from 31 origins to 52 destination places, or a total of 3,898 observations.

Key Findings

Most of the empirical evidence linking population growth and deforestation support the view that large population densities contribute significantly to deforestation, either directly or through interactions with other socio-economic and environmental factors (Cruz et al. 1992; Panayotou 1991; Repetto 1990). At the same time, there are many, and complex, underlying causes of high population densities in forests, including the "push" factors of population growth and poverty, and the "pull" forces that make forests attractive destination places. For example, areas with high upland population densities and increasing in-migration are the semi-cleared forests, logged-over sites, and timber concession areas. These forest lands attract migrants due to their relative accessibility.

The results of the model are presented in Table 7.[7] Because there is no single set of factors that can fully explain forest migration, the model looks explicitly at the combined effects of economic, environmental, and demographic factors. Clearly, the implications of such a result have to do with the types of interventions that are needed in controlling migrant encroachments into forests. For example, intersectoral programs addressing the "push"

factors associated with poverty alleviation and population reduction need to be coordinated with policies related to land tenure, rural credit, and employment generation. At the same time, the model shows that these programs should be linked to policies that "pull" migrants into forests, such as land classification schemes and property rights in forests, roads and other infrastructure, logging and timber concessions, and fuelwood and energy pricing policies.

The following key findings describe the set of factors which are significant within such an intersectoral framework.

Economic Conditions: Income and Poverty. Because incomes of migrants are much lower than the national average, the costs of moving over long distances serve as a deterrent to forest migration, accounting for a significant reduction in movements towards more remote, inaccessible forests. Aside from costs, the important and policy relevant findings are income and poverty. As expected, an increase in average household income and a reduction in the incidence of poverty at the places of destination significantly increase migration into forests. By contrast, the results suggest that targeted reforms which increase lowland incomes can improve economic well-being at the places of origin, thus reducing the incentives to move.

Non-availability of Cultivable Lands. Provinces with large areas under intensive cultivation, and working through the effects of unequal land distribution, landlessness, and rising unemployment in agriculture, increase forest migration. Although not measured directly in the model, these results are closely related to availability of agricultural land and employment opportunities, which tend to slow down migration. Effective rural development programs, which address issues related to land access, tenure, and employment at the places of origin serve as incentives to stay, thereby reducing pressures for opening up forest lands for cultivation.

Property Rights in Forests. Because there are no data on property and tenure in forests, the model makes use of a proxy: the percentage of public forest land in the place of destination. Since more than one-half of the country's land area is classified forest under government control, efforts to protect these lands have been ineffective. The result is rampant occupation of forests by migrants who perceive these lands as virtually "open access" areas. Thus, the larger percentages of area under public forest classification, the

more migrants it received. The implication is that government needs to enforce a rational land classification scheme and provide clearly defined property rights to forest occupants, who can be more effective in enforcing use rights and preventing future migrant encroachments.

Accessibility of Forest Sites. An interesting result is that the purely physical attributes of forest lands (e.g., slope, soil type, elevation, terrain), or those which provide indications of the area's suitability for occupancy and agriculture, did not appear as important determinants of migration. In addition, a migrant's choice of destination is not affected by how much arable land is left in the province. Instead, what appears as more important are policies affecting the perceived attractiveness of forest sites (e.g. road access, tenure), rather than purely on-site physical factors. This is supported by long-term and cross-section migration data showing migrant concentrations in logged-over sites and forest lands near roads and markets. Thus, policies on rural infrastructure at, or near, the frontier; property and tenure in forests; and forest land classification and allocation systems can play important roles in controlling the volume and direction of migration.

Population Density. Demographic factors are also important. Large lowland population densities at origin positively influence migration. In contrast, upland density by itself did not have a significant impact on migration, but upland population growth rate, which reflects demographic expansion, increases migration. This is understandable since density reflects a "crowding effect" on the resource and is most useful in places with uniform land capability or potential. For example, a low population density of 50 to 100 persons per square kilometer in forests may, in fact, already imply crowding since only a limited area can be easily cleared and cultivated given the topography and terrain.

The results show that migrants are attracted to forest areas with already large populations, as shown from evidence of concentration of movement into already dense forests in the 1980 to 1990 migration survey. This observation is consistent with village surveys in forest areas in India where small forest communities with 10 to 25 families experienced difficulties in mobilizing resources for tree planting and farming compared to their counterparts in larger forest communities with 50 to 75 families (Agrawal 1996).

The rates of upland cropland expansion are also more rapid in provinces with already large forest populations. The only exceptions are the remote, high elevation forest areas

which are the sites of the biodiversity conservation protected parks and sanctuaries. However, these areas, although containing low population densities, have begun to experience substantial increases in fuelwood cutting from nearby villages.

V. CONCLUSIONS

Addressing the root causes of forest and biodiversity loss will require interventions that are cognizant of the inter-related effects of population, poverty, and environmental degradation. Economic and social policies that help the poor will have significant environmental beneficial impacts if these are combined with programs that reduce the attractiveness of opening up new lands for cultivation. Property laws and clearly defined land classifications at the frontier are just as important as health and family planning programs in addressing the problems of deforestation and biodiversity loss.

This paper does not discuss the range of issues and recommendations for an inter-sectoral approach to forest and biodiversity management. However, the following are suggested as starting points for designing such an approach.

Examine Long-Term Trends in Population Distribution and Poverty. The Philippines case study demonstrates the importance of establishing a long term and cross-sectional data base that provides the linkage between changes in population distribution and incidence of poverty with deforestation patterns. Population growth and migration can be evaluated in terms of economic and social policies within a particular time period and area. The insights gained from the historical descriptions will be valuable in setting up the parameters for more detailed quantitative analysis.

Determine the Key Policy Variables. Because resources are limited, relevant interventions will have to be targetted to specific policy reforms which have the greatest impacts on reducing biodiversity loss. Similarly, bettter designed programs and activities, which address the immediate problems or threats to forest and biodiversity resources, can be linked to key policy variables. The econometric model shows, for example, that roads and ill-defined property rights in forests contribute to larger in-migration at almost the same scale in which logging opens up new areas for would-be migrants.

Focus on Community-Based Programs. The evidence suggests that, at least for the Philippines, community-based programs will be important for the long-term sustainability of resource use. Population sizes are large, and growing rapidly, in many upland sites. Some of the newly opened forest farms are already in steeply sloping lands where soils are fragile, indicating a decline in availability of the more accessible uplands. At the same time, new forms of property management among upland residents, including various forms of common property regimes, have emerged in response to the need to enforce controls over future migrant encroachments. Unless the existing use-rights to the uplands are recognized, especially those belonging to indigenous peoples in the remote forests, there will continue to be tensions in access to resources which will have the effect of discouraging adoption of longer term conservation practices.

Differentiate Deforestation From Degradation. Both forestry statistics and land classifications in the Philippines do not differentiate between changes in forest cover due to logging and other forms of biomass reduction, such as fuelwood cutting and collection of non-timber forest products. Although it has been shown that logging eventually leads to the permanent conversion of forests into agriculture, the effects of forest degradation remain largely undocumented and under-reported. This will have significant implications on the manner in which forest and biodiversity resources are monitored in the country and the effects that a weak data base will have in the design of programs for maintaining the habitat of endangered and endemic species. Because degradation, in terms of biomass reduction and habitat fragmentation, are closely linked with activities of large numbers of people, solutions will have to come from policies which deal with delivery of family planning, health, and social services as well as with poverty alleviation programs.

Establish the Links to Economywide Policies. The results of the migration analysis indicate the close interaction between economywide policies and environmental degradation. The linkages are many and complex but surely not intractable. For example, the price of kerosene and the high costs of electric, gas and kerosene-based cooking appliances have encouraged widespread use of charcoal and fuelwood. Agricultural policies that affect rural incomes and employment play important roles in establishing the correct incentives for people to stay while the domestic price of timber and cut wood motivates increased small-scale logging to meet local demand for housing and furniture. These observations support the

need to look at both forest sector and economywide policies in designing programs for sustainable forest management, as well as the need for innovative inter-ministerial cooperation.

Translate Research Results Into Policy-Relevant Options. The usefulness of research such as these lies in the translation into policies and activities. Specifically for the Philippines, the key policy implications are that alleviating poverty and reducing pressures from population growth will have tremendous effects on forests and biodiversity resources. As a general, long-term approach, the country is moving in the right direction when it launched its rural development and decentralization programs aimed at increasing rural incomes and employment. However, incentives for motivating industry and infrastructure development in the rural areas still need to be strengthened and followed-through with rationale land classification policies.

Secondly, the research results support the government's land redistribution policies. Through land tenure reforms and expanded agricultural credit schemes, the root causes of out-migration can be addressed. To be more effective, the scope and the budgets for carrying out these programs, will have to be expanded to cover twice as many provinces and beneficiaries. There are also numerous advantages in coordinating implementation of these programs with non-governmental organizations (NGOs), the private sector, and other groups of the civil society.

Together with rural development, the country needs to allocate more resources to outreach schemes that improve the delivery of family planning, health, and social services. Because fertility rates cannot be expected to fall unless these services are available to rural women, population programs need to be accorded the same kind of priority as agricultural and economic plans.

Lastly, on-site and forest sector policies are important. These policies should be aimed at reducing the attractiveness of forests by entending enforceable property rights to current forest occupants and indigenous peoples. The confidence and support of these people are vital so that they become partners in ensuring sustainable forest use and in controlling future encroachments.

ENDNOTES:

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[1] Endemism is the percentage of flora and fauna species unique to a particular area relative to the total number of species found in that area. High species endemism is often associated with dense habitats (Soule 1986).
[2] The NIPAS was developed based upon a study coordinated by the World Wildlife fund-US (WWF-US), University of the Philippines Science Foundation, and the Foundation for Sustainable Development, Inc., with financial support from a Japan-World Bank Technical Assistance grant. It was completed in 1991 to 1992.
[3] This project covers ten NIPAS sites, representing six of the most important bio-geographic zones and covering a total area of almost 1.25 million hectares of forests and wetlands.
[4] The on-site replacement cost of soil nutrients lost with this level of erosion is estimated at about US$50 annually per hectare (W.Cruz and M. Cruz 1991). In the Magat watershed alone, the gross annual economic loss is US$9.0 million for an area that covers 176,800 hectares of open, cultivated and grazed lands. The World Bank (1989) estimates the national annual erosion loss to be in the order of US$100 million.
[5] Such discrete choices are especially suited for the Philippines. There are over 70 provinces and 709 upland municipalities. Further, forest lands vary in terms of their suitability for cultivation.
[6] The sampling frame of this national survey was explicitly designed to capture differences in lowland vs. upland areas. The major limitation, however, is that not all provinces were included in the sample, but this was offset by adjusting income data with information from other sources (e.g., published agricultural income surveys and records of government departments).
[7] Because this is not a standard migration model, there are no separate classifications of "push" and "pull" factors. For information on demographic migration modelling using environmental variables, see Bilderback (1986).

Table 1. Land Use Classification in the Philippines (as of 1988)

Land Use/Cover	Area (sq. kms.)	Percent of Total Area
Forest	72.26	23.92
Pine	0.81	0.27
Mossy	2.46	0.81
Dipterocarp	66.29	21.94
closed	24.35	8.06
open	41.94	13.88
Mangrove	1.49	0.49
Others	1.21	0.40
Extensive Cultivation	119.58	39.58
Open in Forest	0.30	0.09
Grassland	18.13	6.00
Mixed Grass, Brush, Plantation, etc.	101.14	33.49
Intensive Cultivation	97.29	32.58
Plantation	53.36	17.67
Coconut	11.33	3.75
Others	0.91	0.30
Coconut/Cropland	37.48	12.40
Other Cropland	3.65	1.20
Cropland	43.92	14.54
Fishponds	2.05	0.67
Fishponds From Mangroves	1.95	0.64
Other Fishponds	0.10	0.03
Non-Vegetated Areas	1.01	0.34
Eroded Areas	0.007	0.002
Quarries	0.08	0.02
Riverbeds	0.81	0.27
Other Barren Land	0.10	0.03
Other	4.39	1.45
Built-up Areas	1.31	0.43
Marshy Areas	1.03	0.34
Lakes	2.05	0.68
Unclassified	5.46	1.80
Total (All Land Uses)	302.05	99.96

Sources: Swedish Space Corporation, *Mapping of the Natural Conditions of the Philippines* (Solna, Sweden, 1988); Wilfrido Cruz, Herminia Francisco, and Gregory Amacher, "Poverty, Migration, and Deforestation in the Philippines," in Jeremy Warford, Mohan Munasinghe, and Wilfrido Cruz, *The Greening of Economic Policy Reform* (Washington D.C., The World Bank, 1996).

Table 2. Number of Threatened, Known and Endemic Species in the Philippines (as of 1990)

	No. of Threatened Species	No. of Species Known	No. of Endemic Species
Plants	159		
Mammals	12	166	90
Birds	39	395	172
Reptiles	6	193	131
Amphibians	0	63	44
Fish	21		

Source: World Conservation Monitoring Centre (WCMC). *Global Biodiversity: Status of the Earth's Living Resources*, ed. by Brian Groombridge (London: Chapman and Hall, 1992) Tables 17.3 and 13.1.

Table 3. Estimates of Remaining Tropical Moist Forest and Percentage in Protected Areas in the Philippines (as of 1990)

	Satellite-Based Land Use Survey (1988)	IUCN Estimate (1990)
Remaining Tropical Moist Forest (TMF):		
Area (sq. kms.)	6,629	6,600
Percent of Total Land Area	22	22
Area with Closed Canopy Forest (sq. kms.)	2,435	2,950
Percent of TMF Declared as Protected Area:	37	45
Existing (sq. kms.)		1,775
Proposed (sq. kms.)		620

Source: National Research Accounting Project (NRAP). *Final Report of Phase I Activities* (Manila, Philippines: Department of Environment and Natural Resources and United States Agency for International Development, 1991); World Conservation Monitoring Centre (WCMC). *Global Biodiversity: Status of the Earth's Living Resources*, ed. by Brian Groombridge (London: Chapman and Hall, 1992).

Table 4. Number, Annual Growth Rate and Net Increase in Migrant Population in Forest and Upland Areas in the Philippines, 1950 to 1990

	1950	1960	1970	1980	1990
Population in Forest and Upland Areas (thousand persons)	5,868	8,192	11,169	14,440	17,483
Annual Growth Rate (percent)		3.39	3.15	2.60	3.93
Net Migration Rate (percent)		-4.20	3.40	9.40	14.50
Annual Growth Rate in Timber Concession Areas (percent)		4.58	4.72	3.49	n.d.

n.d. = no data available

Sources: National Statistics Office (NSO), *Population Census*, adjusted and reported in Maria Concepcion J Cruz, Imelda Zosa-Feranil and Cristela L. Goce. "Population Pressure and Migration: Implications for Upland Development in the Philippines," *Journal of Philippine Development*, XV:1 (1988); 1990 population reported in Wilfrido Cruz , Herminia Francisco, and Gregory Amacher. "Poverty, Migration and Deforestation in the Philippines," in Jeremy Warford, Mohan Munasinghe and Wilfrido Cruz. *The Greening of Economic Policy Reform* (Washington D.C., The World Bank, 1996).

Table 5. Indicative List of Protected Areas Identified in the National Integrated Protected Areas System of the Philippines, Number of Municipalities, Population and Annual Growth Rate

Bio-Geographic Zone	Identified Protected Area	No. of Municipalities	Population (1990)	Annual Growth Rate (1980-90)
Batanes	Sabtang/Itbayat Islands	1	628	1.2
	Mt. Iraya	1	609	1.2
	Yami, et. al.	2	916	1.4
Central Cordillera	Magat Forest Reservation	4	23,902	2.8
	Mt. Pulog	3	13,514	2.5
	Mt. Data	3	16,943	2.5
Sierra Madre	Sierra Madre Mts.	3	23,881	2.3
	Palani Island	2	8,473	2.1
	Cagayan River	n.d.	n.d.	n.d.
	Mt. Binuang	2	4,149	2.5
	Mt. Arayat	2	73,189	3.5
Southern Luzon	Balayan Bay	n.d.	n.d.	n.d.
	Pagbilao Bay	n.d.	n.d.	n.d.
	West Calatagan Reefs	2	66,146	3.1
	Taal Lake	3	46,944	3.4
	Lobo	2	13,438	2.8
	La Laguna Marsh, Lopez	2	15,495	2.6
	Quezon National Park	3	36,320	2.8
	Mt. Makiling	3	27,539	3.1
	Mt. Banahaw	3	17,965	3.0
	Minasawa Island	n.d.	n.d.	n.d.
	Tayabas Bay	n.d.	n.d.	n.d.
	Manlubas Swamp	2	21,577	2.5
	Ragay Gulf	n.d.	n.d.	n.d.
	Mt. Lobo	2	27,515	2.1
	Bicol National Park	3	72,560	3.5
	Mt. Isarog	3	53,016	3.1
	Mayon Volcano	3	16,011	2.1
	Mt. Bulusan	3	5,621	2.5
	Bulusan Lake	n.d.	n.d.	n.d.
	Mt. Pulog-Palay Mataas	3	13,105	2.1
	Na Gulod	2	4,048	1.8
	Lake Buhi	3	57,495	4.1
	Lake Bato	2	35,294	3.1
	Aurora National Park	3	49,501	3.0

Zambales	Mt. Pinatubo	3	15,337	1.5
	Candaba Swamp	3	68,215	3.1
	Bataan National Park	3	19,719	1.8
Mindoro	Mt. Iglit Baco	3	7,549	2.5
	Mt. Halcon	2	13,609	2.1
	Lake Naujan	n.d.	n.d.	n.d.
	Puerto Galera Bay	n.d.	n.d.	n.d.
	Apo Reef	2	2,332	1.2
Western Visayas	Mt. Canlaon	4	52,452	2.6
	Philippine Deer Sanctuary	2	6,243	1.2
	Taklong Island	n.d.	n.d.	n.d.
Eastern Visayas	Mahagnao	2	6,638	2.1
	Timber Prod. Mkt. Cor.	n.d.	n.d.	n.d.
	Wilder.	n.d.	n.d.	n.d.
	Lake Danao	3	19,900	2.5
	Rajah Sikatuna			
Calamian	Coron	2	9,958	2.1
Palawan	El Nido	2	18,832	2.5
	St. Paul	2	31,538	2.5
Sulu	Turtle Islands	2	1,196	1.3
Mindanao	Mt. Malindang	2	9,987	2.1
	Rungkunan	2	6,670	1.8
	Lake Dapao	n.d.	n.d.	n.d.
	Salikata	3	18,343	2.1
	Mt. Apo	2	7,336	1.6
	Siargao	2	25,202	2.5
	Mt. Kitanglad	3	13,676	1.4
	Agusan Marsh	2	13,530	2.0
Liguasan	Liguasan Marsh	n.d.	n.d.	n.d.

n.d. = no data available

Source: Global Environment Facility and The World Bank. *Republic of the Philippines Conservation of Priority Protected Areas Project (* Washington D.C., The World Bank, 1994) Annex B, p. 1-2; adjusted population from National Statistics Office, *Population Census*, reported in Wilfrido Cruz, Herminia Francisco and Gregory Amacher. "Poverty, Migration and Deforestation in the Philippines" in Jeremy Warford, Mohan Munasinghe and Wilfrido Cruz. *The Greening of Economic Policy Reform* (Washington D.C., The World Bank,1996).

Table 6. Land Area, Population and Annual Growth Rate in Ten Priority Protected Areas and Number of Municipalities, Population and Annual Growth Rate in the Buffer Zone, 1980 -1990

Priority Protected Area[a]	Land Area (sq. kms.)[b]	Population (1990)[c]	Annual Growth Rate of Pop. (1980-90)	No. of Municipalities in Buffer Zone[d]	Pop. in Buffer Zone (1990)	Annual Growth Rate of Pop. in Buffer Zone (1980-90)
Mt. Canlaon National Park	323.5	52,452	2.6	4	124,716	2.6
Northern Sierra Madre Nature Park[e]	2,402.3	23,881	2.3	5	85,689	2.8
Batanes Landscape and Seascape	203.2	1,122	2.1	3	17,241	2.5
Siargao Wildlife Sanctuary	603.9	6,338	2.6	4	57,200	2.8
Bataan Nature Park	271.7	19,719	1.8	3	33,904	2.5
Mt. Kitanglad Nature Park	311.4	13,676	1.4	4	45,923	2.5
Apo Reef Nature Park	0.29	2,332	1.2	3	46,468	2.5
Mt. Apo Nature Park	654.8	7,336	1.6	3	38,092	2.5
Agusan Marsh and Wildlife Sanctuary	224.6	13,530	2.0	4	63,169	2.5
Turtle Islands Marine Nature Park	3.92	1,926	1.3	2	29,652	2.5

Source: Global Environment Facility and the World Bank. *Republic of the Philippines Conservation of Priority Protected Areas Project* (Washington D.C., The World Bank, 1994); Annex C, p. 1-9; population from National Statistics Office, Population Census; adjusted and reported in Wilfrido Cruz, Herminia Francisco and Gregory Amacher. "Poverty, Migration and Deforestation in the Philippines" in Jeremy Warford, Mohan Munasinghe and Wilfrido Cruz. *The Greening of Economic Policy Reform* (Washington D.C., The World Bank, 1996).

Table 7. Multinomial Discrete Choice Estimates of Determinants of Forest Migration

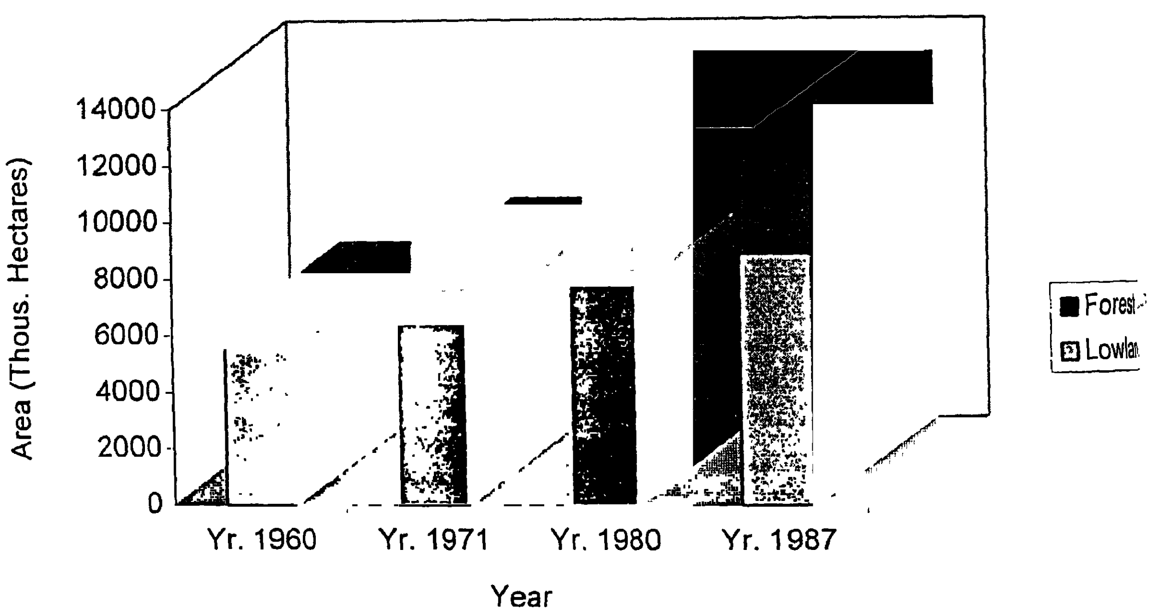
Migration Factors/Expected Link to Forest Migration	Coefficient	Standard Error
Economic Factors:		
Average Household Income	3.97**	1.465
Poverty Incidence (percent)	-3.74	1.216
Average Upland/Forest Land Income	0.208**	0.058
Average Provincial Lowland Income	-0.038	0.067
Unemployment Rate in Province (percent)	18.87	20.68
Population Employed in Agriculture (percent)	-1.97	2.137
Farm Area Tenancy/Lease Rate	0.11	0.26
Index of Cost of Long-Range/Long-Distance Migration	-33.03**	1.01
Urbanization Rate in Province (percent)	-0.32	0.427
Literacy Rate (percent)	-11.53	20.49
Environmental Factors:		
Upland/Forest Cultivated Area (sq. kms.)	-1.54*	0.922
Arable Land in Province (sq. kms.)	0.519	0.614
Land Under Extensive Cultivation (percent)	0.494	0.416
Land Under Intensive Cultivation (percent)	1.081**	0.438
Forest Land in Province (percent)	0.906	0.77
Land Area with Greater Than 30% Slope in Province (%)	0.352	0.255
Public Forest Land in Province (percent)	1.05**	0.322
Road Density in Upland/Forest Area (kms./sq. kms.)	1.27**	0.468
Demographic Factors:		
Lowland Population in Province (1980)	3.55*	1.929
Upland/Forest Population (1980)	0.78**	0.302
Upland/Forest Population Density (1990)	-1.63	1.20
Annual Population Growth Rate (1980-1990)	1.37**	0.34

Notes:

1. Log likelihood is -292.39; F-Statistic is 0.0033.
2. The symbol (*) denotes significance at 0.10 level and (**) denotes significance at 0.05 level.
3. All factors/variables refer to destination province, unless noted otherwise.
4. Index of Long-Range/Long-Distance Migration equals one if upland migration is to another province; zero if within province.

Source: Wilfrido Cruz, Herminia Francisco and Gregory Amacher, "Poverty, Migration and Deforestation in the Philippines," in Jeremy Warford, Mohan Munasinghe and Wilfrido Cruz, *The Greening of Economic Policy Reform* (Washington D.C., The World Bank, 1996) Table 7, p. 19.

FIGURE 1. Expansion of Agriculture in Forest Lands of the Philippines, 1960-1987



Source NEDA 1989. Philippine Statistical Yearbook. Manila: NEDA

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Perception and communicty participation on population and environment in transmigration area: Case Study — Lampung, Indonesia

Submitted by
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Perception and community participation on population and environment in transmigration area: Case study — Lampung, Indonesia

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1. Introduction

Indonesia is one of the most populous countries in the World, only after China, India and the U.S. The total population in 1990 was 179.3 million and in 1995 was projected to be 195 million. The population problem in Indonesia is the high growth rate (around 1.6 % now) and uneven distribution of population — about 60 % of the population of Indonesia lives in Java which consists of only 6 percent of the land in Indonesia. To overcome this problem the Indonesian government introduced a transmigration program which is the largest available program in the world to move the people from Java-Bali to other Islands. In the past, this program was also introduced by the Dutch Colony, which was called colonization. Lampung is the province located in the Southern part of Sumatra. The Lampung population has increased tremendously from 6 million in 1990 to 6.5 million in 1995 with an annual growth rate of 1.69 %. The migrants contributed about 0.35 % of the Lampung population growth rate. This high growth reflects the success of the transmigration program because most people who came to Lampung in the last two decades were self supported. One of the reasons is the proximity of the Lampung province to West Java (only 1AB hours by Ferry). On the other hand, however, these migrants also disturb the environment.

2. The Impact of transmigration on environment in the province of Lampung

The first province to have experienced transmigration was Lampung. This first transmigration program, which was called colonization, was started in 1905 by the Dutch Colonial government. This program reallocated people from Java to Gedong Tataan. Since that first program, Lampung had accommodated migrants from Java.

The transmigration process into Lampung had been done from time to time. In general, the process can be categorized into four phases. They are:

a. Colonial Era Transmigration

During the Dutch Colonization, from 1905-1942, 44,681 households (HH), or a total of 180,020 people were reallocated into Lampung from Java and during the Japanese occupation, 6,329 HH or 31,700 people were moved.

[1] Both the authors are researchers at the Demographic Institute, Faculty of Economics, University of Indonesia and this paper was summarized from a study by the authors at Gunung Balak, Central Lampung, Indonesia

b. Pre-Pelita transmigration, 1950-1969

During this period 53,280 HH or 220,663 people were reallocated to South Lampung, Central Lampung, and North Lampung.

c. General Transmigration before ACT no. 3/1972

Before ACT no. 3/1972, the province of Lampung has 21 types of transmigration programs that are sponsored by various government institution, such as Ditjen of Transmigration, Ditjen of Social Work, Hankam Kwarnas (National Defense), Pramuka (Scout), Integrasi ABRI (The Military Integration), Pamen, Banpres (The Presidential Grant) and Polri (Indonesian Police Force). During this period 15,241 HH or 71,945 people were reallocated into Lampung.

d. Transmigration after 1972

After 1972, the Ministry of Transmigration is responsible of all transmigration activities in Indonesia, and the number of migrants reallocated into Lampung continued to increased. During Pelita I (The First Five Year Development Program) 15,539 HH or 69,658 people were reallocated into Lampung, and 6,500 HH or 28,999 people in the Second Five Year Development Program (Pelita II).

Meanwhile, the success of the government's transmigration program induced spontaneous migration into Lampung. These spontaneous immigrants came to Lampung through immigrants from Java that are already there, or from other parts of Sumatra. The flow of these spontaneous immigrants was generate by the strategic location of Lampung province. Lampung is located along the transportation route between Sumatra and Java.

In the end the flow of immigrants to Lampung, both spontaneous and through government programs, increased the population size and growth rate. Population growth rate between 1971-1980 in Lampung was 5.77%. This rate includes, birth rate 2.33% and flow of migrant 3.44%. Population density in Lampung also increased, in 1971 population density was 78 person per squared kilometer and by 1990 it has reached 170 person per squared kilometer.

Unfortunately, the high population growth rate was not followed by equal population distribution between Kabupaten (regencies) in Lampung province. This could be seen by the various density rates in each Second Level Administrative Region (Daerah Tingkat II or Dati II).

The regent of West Lampung has an area of 4,950 square kilometer and a population size of 309,050, whereas the municipality Bandar Lampung with an area of 169 square kilometer has a population size of 636,418 people. Differences of area and size of population that lived in it caused various density rates in every Dati II.

Population growth rate has pressured the land. Areas that formerly had been forest land were converted into farm land and settlement to build new houses, hospitals, roads and other

accommodations.

From the data collected by the Kanwil Kehutanan of Lampung (Regional Forestry Office) showed that at least 416,021 hectares had changed function from forest land to farm land and settlement area. Only 26.03% or 817,093 hectares of land in Lampung composed of forest land.

This situation is lower than the minimum requirement stated by the 1967 Forestry Law. The 1967 Forestry Law stated that 30% of total area should be conserved for forest land. By 1990, forest land in Lampung has deteriorate to 22.09%.

As shown by the Kanwil's data, deterioration of forest land had brought pressure to the environment. The need for housing and farm lot had caused the process of deforestation to continue. Areas that had originally been forest land were cleared and transformed into housing and farm lot. This situation applies all over Lampung and has been continuing for along time.

Noticing the imbalance between availability of land and population size, the regional government of Lampung had banned immigrants from entering. Since the beginning of The Fourth Five Year Development Program (Pelita IV), Lampung is no longer a designated area for immigrants, but a sender. During Pelita IV Lampung has send 787 HH or 3,432 people to Riau to work at PIR (Perkebunan Inti Rakyat). Pelita V Lampung has exported out of the province 400 HH or 1,471 people to Bengkulu, Jambi, and Riau on Pelita V (The Fifth Five Year Development Program).

Besides conducting outmigration programs, Lampung had initiated local transmigration by reallocating people from conserve protect forest land, flood areas, and river banks (daerah aliran sungai or das). The process of these up-rooting cover areas of Gunung Balak and Way Jepara in Central Lampung, Kota Agung Utara and Batu Serampok in South Lampung, and Bukit Ringis and Way Kenali in North Lampung. These three areas consist of 35,000 HH, from this number only 13,751 HH had been reallocated.

There are lots of factors preventing the operation of transmigration such as: compared to the original location the new location has lesser facilities (especially for migrants from Gunung Balak), differences in the soil quality and acid degree in the soil causing failure in crops. Causing lots of farmers to go back to their original location, and neglecting their new location. On the other hand the government insist in conserving protected forest land and flood areas. There were rumors that the citizens of Gunung Balak do not want to moved out and that people originated from Gunung Balak are going back to the area. Their reasoning is the soil in Gunung Balak is very fertile compare to the land given to them in North Lampung. This infertile soil makes it hard for them to crop using the same method as in Gunung Balak. Considering these problems it will be interesting to study how society perceived towards the environment and their contribution in conserving the environment.

3. Gunung Balak A Case Study: Conflict of Land Use

As stated above in the prior section, problems of land use emerged in Gunung Balak, Central Lampung Regency (Kabupaten Lampung Tengah). The region of Gunung Balak was proposed as forest land by the Chief Administrator of Lampung under Register No. 38 on November 30, 1935. But by 1960's the forest in Gunung Balak was cleared by the military together with migrants under the approval of the forest authority. Deforestation started in the form of selective tree cutting system, however, due to the fertile soil it spread to inter-planting system. It was the fertile soil that attracted migrants to moved into Gunung Balak. They came in groups from neighboring villages to clear and cultivate the land, using inter-planting system.

In the mean time more and more people came to this promised land and before long many hamlets were built, which grew into villages and required public services. Faced with the reality of the development of the area, the Regent of Central Lampung (Bupati Lampung Tengah) confirmed the existence of these hamlets and were given a status of Preparatory Village, through Reference No. 8/1.K/P/Pom/74 dated April 20, 1974. Eventually the region of Gunung Balak was designated as independent Kecamatan (District or Third Level Administrative Region). Through the Governor's Decision No. 6/85 D.I/HK/1974 dated June 13, 1974 Gunung Balak was confirmed as a candidate District (Kecamatan) consisting of 13 preparatory villages with an Administrative District Office at Sidodadi village. The thirteen preparatory villages are: Way Abar, Purwokencono, Bandung Jaya, Ogan Jaya, Sidodadi, Sri Widodo, Sri Kaloko, Sri Katon, Sri Mulyo, Bandar Agung, Sidorejo, Brawijaya, and Majapahit.

The development of the area, however, has been terminated because the government planned to build an irrigation system at Way Jepara Lake which is located north of the villages of Gunung Balak District. People living in the villages located at the catchment area of 13,000 hectares had to abandon their homes for this project. Distances between the villages and Way Jepara Lake varies between 2 - 21 kilometers. Thirteen years after the Governor's decision to confirmed Gunung Balak as a candidate District, the Administrative District Office and all other representative offices of Gunung Balak was abolished. To realized this action the governor stipulated a Decree No. 6/237/B-I/HK/1987 dated October 10, 1987. Nine villages were emptied for reforestation, and four other were administratively transferred to neighboring Districts (Kecamatan).

The villages of Sidorejo and Brawijaya were incorporated into Jabung District, and Bandar Lampung and Majapahit villages into Labuhan Maringgai District. But in 1993 the Majapahit village was to be abandoned, the villagers were reallocated through Local Transmigration Program to North Lampung.

There is a problem in the status of the three remaining villages of the former Gunung Balak, they are Sidorejo, Bandar Agung, and Brawijaya. Other problems also occurred such

as, what is the policy of the local government and the expectation of the villagers.

The case of Gunung Balak shows that the problem of environment requires more than just understanding and participation, it also needs to incorporate firm and consistent policy from the government. In a period less than 30 years (from the beginning of the 1960s to the end of 1980s) government policies changed frequently and are often contradictory. In the 1960s the regional Forest Office allowed people to cut down trees using selective tree cuttings method and plant crops using inter-planting system. By 1974 the Gunung Balak region was promoted to District Administrative (Kecamatan) and the villages were group into preparatory villages. But in 1987 the District (Kecamatan) was abolished and villages that had been developed into the community had to be abandoned for reforestation. Today there are only three villages left and are waiting for their fate to be decided by the government. The villagers in Sidorejo, Bandar Agung, and Brawijaya are always in conflict with the officer from the Regional Forest Office, in managing the land. The villagers wants to cultivate the land to plant crops, where on the other hand the officer wants the villagers to moved so that the land can be reforested and turned it into a protected conservation area.

4. Community Participation In Sustaining The Environment.

One of the basic questions in this study is community participation and attitude (especially Sidorejo village), of the three remaining villages, in maintaining their environment. In-depth interviews and Focus Group Discussion (FGD) had been conducted with a number of respondents from these villages.

Results of interviews and FGD shows that the villagers are ready to implement the environmental programs, both in maintaining the forest area and in planting mutli purpose tree species. All the government need to do is to give guidance on what type of trees to plant in their garden and fields. The villagers are very much enthusiastic and ready to commit themselves to the programs.

"We are not only willing to do what the government wants, but we can do it immediately and right away as long as we are allowed to remain in these villages", said one of the prominent members of the community during a FGD session.

Therefore, the problems does not lie on the question of the community's willingness to maintain the environment but rather on the uncertain status of their villages. There should not be any doubt about the Gunung Balak community willingness to take care of their environment (especially those of Sidorejo village). This can be observed from the eagerness of the community in supporting the development of social facilities. Therefore, it remains to the government in formulating their policy to accommodate community aspirations. This will ensure the maintenance of the environment without sacrificing community interest.

There are cases of forest cutting by government authorities together with people from the community. According to the people that it was not with people from that area, but with

individuals from outside Gunung Balak. This activities according to them was initiated by government employees, or the forest rangers. The community confessed that there are incidents where some individuals from their area gather fire woods from the forest. But they do not cut down the trees, they collect woods from fallen trees and gather them for cooking. When it was confirmed, there are a couple of small fallen sonokeling trees because their roots has rotten.

Based on the facts that there is an activities to steal woods from the forest by forest rangers and thieves from outside the area, the need to preserve and guard the forest is a priority in conserving the forest. The mechanism to protect the forest should include the community in that area, they would need a channel to report their observations and findings. Some of the people even have photo documentation of the illegal forest cuttings. The majority of the respondents even voluntary to be involved in preserving the forest. The decision to involved the community in conserving the forest will lessen the opportunity for the forest rangers in working together with member of the community in cutting down the trees.

5. Conclusion

Based on the above analysis, some conclusion can be drawn such as:

a. The transmigration program that has been implemented in Lampung since 1972 proved to bring lots of development progresses to the province. Hard to reach areas are now center of development and growth. Another side effect of the success in the transmigration program to Lampung is that it also attracts spontaneous migration into the province. The success in transmigration, however, has its down side. Population growth is pressuring the land, causing imbalances between population density and the carrying capacity of the land.

b. Population growth is pressuring the land. Hectares of lands that was formerly forest land has change function into farmland and settlement areas. According to the Provincial Forestry Office, forest land has decrease from 1,233,114 hectares to 817,093 hectares; a reduction of 416,021 hectares. Only 26.03% or 817,093 hectares of land in Lampung is conserve for forestry, this number is lower than the 30% required by the 1967 ACT No. 5 on Forest Law. The dismal part is that by 1990 the percentage has lowered to 22.9%.

c. In the case of Gunung Balak we can learn, that the problem of environment requires more than just understanding and participation, it also need to incorporate firm and consistent policy from the government. In a time span of about 30 years (from the beginning of the 1960s to the end of 1980s) government policies has repeatedly changes and are often contradictory. In the 1960s the regional Forest Office allowed people to cut down trees using selective tree cuttings method and plant crops using inter-planting system. By 1974 the

Gunung Balak region was promoted to District Administrative (Kecamatan) and the villages were group into preparatory villages. But in 1987 the District (Kecamatan) was abolished and villages in the district, that had been developed into the community, had to be abandoned by the villagers for reforestation programs. Today there are only three villages left and are waiting for their fate to be decided by the government.

d. Policy taken towards the fate of the three remaining villages needs to considered legal and sociological realities from the people in reallocating the community. Experiences shows that a policy is effective if and only if the aspiration of the people are build into the policy without being distracted from the main purpose of the policy, that is conserve the environment or forest in the area.

e. The case of the remaining three villages in Gunung Balak remind us of the conflict between development and conserving our natural resources or reforestation. On one hand we want to protect the environment, but on the other hand we need to continued the development process.

f. From the in-depth interview and FGD we can see the community is willing to protect the environment, contribute in conserving the forest, and participate in cultivating perennial plants or multi purpose tree species. The government has only to guide and supervise the community what types of plant to cultivate in their yard and farm land, because the people are ready and willing to participate in the reforestation process.

g. The community perception and participation on conserving the environment depends on the government's policy and its ability to create a conducive condition. The community will respond positively if their aspirations are met by the government, and negatively if policies apply are not in concurrence with the conditions in the field. Base on experience, the community are very sensitive towards government policies.

6. Policy Recommendation

Based on the above description, some recommendation are proposed as follow:

a. Concerned government agencies need to intensively coordinate efforts at adopting necessary policies for the three villages. Present conditions give an impression that each agency is focusing on its own sectoral interest without further analyzing community concern. Inter-agency coordination is necessary to bring together various interest for sustaining the environment, developing the area as well as improving the people's welfare in the three villages. Legal consideration should be adapted to the local conditions and to the existing

sociological realities.

b. The need to re-examine the utilization of land. This includes the question of balance between the number of people and the carrying capacity of the land in every area (including Gunung Balak area); land mapping according to its functions; whether the their villages could maintained as agricultural area and abandonment of plans to vacate and reforest them; how far should the area be developed in view of the carrying capacity of the land. Such study will ensure an integrated process of development.

c. The importance of motivating the people of the three villages to be actively involve in protecting the forest and environment. Their willingness to prepared and take care of the forest land and plant trees of dual functions (Hydrological and economical) need to be analyzed and follow up with an integrated policy.

d. A study is also needed on alternative policies in solving the future of the remaining three villages. A compromised should be identified to achieve the three targets concurrently. First, the forest area should remain intact to preserve the catchment area of Way Jepara Lake. As mentioned earlier this problem emerged from the plan to build irrigation system at Way Jepara Lake area. Therefore, this problem should be reviewed from the Program of Way Jepara Lake. The Decision of Lampung Residency dated in 1935 should be understood in the context of sustaining Way Jepara Lake with its irrigation system. Second, to find ways of keeping the area that had been developed before. How to keep developing without harming forest land and the sustainability of the environment. All kinds of undertaking that have been performed by the government and the local people should not be a waste. Third, these efforts should aim at improving, or at least maintain the present condition, the welfare of the local tenants.

e. The aim can be achieved by making people actively involved in the process of reforestation of their area. The social forestry concept is probably applicable to this area: how to make people cultivate perennial plants known also as Muti Purpose Tree Species (MPTS), which have double functions hydrological as well as economical in addition to horticulture that has economical value.

The MPTS program requires the participation of local people from the beginning. The government (Forest Office) has only to give guidance and supervision, while the cost of planting and maintaining (the forest) is the responsibility of the community.

f. Continue public information activities through extension services need to be carried out to inform the people on the importance of protecting the forest and preserving the environment. Community leaders in the three villages should be involved in thiscampaign through

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How China has succeeded in fueling the world's biggest population and a fast growing economy

Submitted by
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How China has succeeded in fueling the world's biggest population and a fast growing economy

Yingzhong Lu[1]

1.0 Chinese population growth

China is the most populous country in the world. Even under a vigorous family planning and birth control program, the Chinese population has been more than doubled since 1952, and attained an astonishing number of 1.2 billion in 1995. The increment of population from 1980 to 1995 amounted to some 220 million within 15 years, that almost corresponding the population size of the whole United States! Table 1 gives the total population increase and the percentage by residence in the PRC (excluding the population in Hong Kong, Macao, and Taiwan). In Table 2, the annual birth rate, death rate, and natural (net) growth rate of Chinese population are shown. It is noted that, although the birth rate dropped substantially after 1975 when birth control policy was put into effect, the net growth rate still remained over 1.1% because of the declining of death rate. It is forecasted that, if the current birth control policy continues, the Chinese population will attain a maximum value of 1.4-1.5 billion early 21st century before leveling off. The rapid population growth has imposed serious burden on Chinese economic growth and energy supply.

Table 1. The total population of the PRC

Year	Total Population (Million)	Urban (Percentage by Residence)	Rural (Percentage by Residence)
1952	574.82	12.46	87.54
1962	672.95	17.33	82.67
1970	829.92	17.38	82.62
1975	924.20	17.34	82.66
1980	987.05	19.39	80.61
1985	1058.51	23.71	76.29
1990	1143.33	26.41	73.59
1995	1207.66	28.22*	71.38*

* 1994 data

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Table 2. The growth rate of Chinese Population

Year	Birth Rate	Death Rate	Nat. Growth Rate
1952	37.00	17.00	20.00
1962	37.01	10.02	26.99
1970	33.43	7.60	25.83
1975	23.01	7.32	15.69
1980	18.21	6.34	11.87
1985	21.04	6.78	14.26
1990	21.05	6.67	14.39
1994	17.70	6.49	11.21

2.0 Economic growth

The development of Chinese economy has undergone a tortuous path. In the 1950s, the Chinese Communist Party (CCP) pursued a Marx-Leninist line and followed the USSR pattern of socialistic economic development. Heavy industrial was put in first priority on the expenses of people's living standard. In particular, the living standard of the peasants, who constitutes over 80% of Chinese population, was actually declined. People were frustrated. Social conflicts intensified.

In 1958, the late CCP president Mao try to solve the problem by pushing the Chinese economy further toward his own "Chinese Communism." He put forth the policy of so-called "Three Red Banners," i.e., the Party's General Line; the Great Leap Forward; and the People's Commune. Such a policy seriously violated any economical rules, and, thus, resulted in unprecedented economical disaster. Millions of people were perished in the man-made famine.

In 1966 Mao launched the notorious "Cultural Revolution" in the hope to regain his control of the country. Political crisis resulted. The Chinese economy was brought to the verge of bankruptcy.

After Mao's death in 1976, the new CCP leaders tried to change the orthodox political line. Den Xiao-Ping put forth his economic reform policy in 1980, trying to gradually transform the central planning system with market economy. The new "Reform and Open" policy actually introduced capitalism into the "Chinese socialism," and a strange hybrid economy grew up. These new policies have achieved great success in the past 15 years.

In 1980, a target of economic growth, "Quadrupling the National Gross Product (in real term) by the year 2000," has been declared by the CCP. At that time, many experts considered this target was too ambitious and openly expressed their doubts. However, the development of events has proven it is a powerful, correct policy. This "ambitious" target has been accomplished years ahead schedule. By the end of 1995, the Chinese government declared that its GNP has quadrupled the 1980 value in real term. In Table 3 the current values and the growth rates of the year 1980, 1985, 1990, and 1994 were listed.

Table 3. Chinese GNP growth since 1980

Year		1980	1985	1990	1994	1995**
Gross National Product (GNP)*	Billion RMB	541.78	899.46	1854.47	4491.80	5682.13
	% of 1980 Value	100.00	166.29	242.67	384.66	423.13
Per Capital GNP	1980 RMB	602.75	766.82	897.03	1227.37	1350.16
	% of 1980 value	100.00	127.22	163.75	203.63	224.00

* Absolute values in this block are based on current price; percentages are based on comparable prices
** Estimates based on unofficial growth and inflation rates information. The official 1995 value will be available in mid-March 1996.

The most important policies contribute to the success of Chinese economic reform are the following:

a) The rural reform priority policy. In fact the Chinese economic reform began with an active rural reform program, i.e., the abandonment of the effort of the Peoples Commune, and the privatization of land under so-called "responsibility system". This policy decisively brought into play the initiative of the peasants, improved the living standard of over 80% of the Chinese population, and guaranteed plenty food supply to the urban region. As a consequence, this policy earned both economical and political credits for the Chinese economic reform.

b) An aggressive "Open-door" policy consists of the establishment of "Economic Special Zones" and many other favorable terms for foreign investors.

c) A controlled privatization policy that allows the growth of private sector inside China alongside with the management reform of the government-owned enterprises.

d) A stringent macro-economic control policy that keeps the inflation rate within the acceptability of the population.

A number of new problems emerged in the economic reform process. The most obvious drawback is the resistance of CCP to political reform. Serious corruption and racketeering resulted. People were disappointed. This triggered the uprising in 1989 and the followed Tian'anmen bloodshed. The other drawbacks include the poor performance of the government-owned enterprises, the increasing gap between the rich and the poor regions, and the social conflicts among the new classes. Detailed discussion of these issues is outside of the scope of this paper. The readers may refer to some other articles 2 for a better

the scope of this paper. The readers may refer to some other articles 2 for a better understanding of the root causes and possible solutions.

3.0 Energy consumption and supply for Chinese population and economic growth

3.1 The Bottleneck of Chinese Economic Growth

As already mentioned, many Chinese and foreign experts cast doubts on the 1980 ambitious target of "Quadruple the GNP by the year 2000." This target corresponds to an average annual growth rate of 7.2% over a period of two decades. It was not considered unattainable perse. The main concern at that time was whether there could be sufficient energy supply to support thiambitious goal. The world had just suffered and hardly recovered from two energy crises. Many fast growing developing countries suffered seriously drawback and ran into deep debts.

With a huge population of near 1 billion, China consumed 600 million tons coal equivalent (tce) commercial energy in 1980, ranking the third in the world. Per capita energy consumption in China, however, was only 0.6 kgce. This amount was less than 5 percent of the energy consumption in the United States. Such a low level of per capita energy supply could hardly support the ambitious economic goal.

In 1979, Chinese economy suffered from serious energy/power shortage, and about one third of its industrial capacity was idled. Chinese households could hardly get sufficient fuel for cooking and heating. Fuel shortage in vast rural region resulted in excessive deforestation and serious decertification. Because of the regulated very low energy prices, Chinese energy producers, in particular the coal mines, were almost bankrupt. In short, the entire Chinese energy system then was in a chaos. Who could believe that a fast growing economy could take-off on a shattered energy supply base?

In addition, the ruling CCP insisted its ideological control and was very reluctant to accept western economical thoughts. Even many economical terminologies such as "cost of money," "investment return," or even "elasticity," etc. were considered "anti-Marxism" and prohibited.

Chinese energy experts, therefore, were facing both political and technical challenge in preparing a scientific energy policy for re-structuring the Chinese energy system.

However, despite of all the difficulties and uncertainties, a scientific energy policy was born in 1981 and successfully implemented thereafter. Fifteen years later, the development of events has demonstrated that the 1.2 billion Chinese people and the ambitious goal of the Chinese economic reform have been more or less adequately fueled, and the ambitious goal of "Quadrupling the GNP" has been realized within 15 years!

The story of the success of the development and implementation of Chinese energy policy has been described in details in my 1993 book entitled "Fueling One Billion--An Insider's Story of Chinese Energy Policy Development."3 Only the most important experience will be briefly discussed in this short article.

3.1.1 "Quadrupling the GNP with Doubling the Energy Provision"

The average energy elasticity of Chinese economic growth from 1953-1980 was 1.66. If the trend would continue from 1980-2000, Chinese energy demand by the year 2000 will attain 5,726 Million tce, far more than current world total energy production. It is impossible to meet this demand.

Even if the energy elasticity reduced to around 1.0, similar to that in many newly industrialized countries, the commercial energy demand by 2000 will be some 2,400 Million tce, or quadrupling the energy production. Taking into consideration of the tremendous capital investment required and the long lead time of capability building, to quadruple the energy production within two decades is too ambitious to be a reality.

After careful analyzing the energy conservation and provision potential, the goal of the Chinese energy policy was aimed at "quadrupling the GNP with doubling the energy provision." This required that the energy elasticity must be reduced from the previous average value of 1.66 to about 0.50. Great efforts on energy conservation must be made. Is such a target feasible?

Even the target of doubling the energy supply, i.e., increase some 600 million tce, within two decades is still a tremendous challenge. Energy industry is a highly capital-intensive enterprise, and it need a long lead time. Special measures must be taken to accelerate the development of new production capacity.

There was another knotty problem that has not yet been touched. The rural region relies on non-commercial energy that has not been counted in the above figures. The rural household energy was in serious shortage. Biomass fuel supply was declining due to excessive deforestation over a long period of time, and large-scale commercial energy supply to the vast rural region was unrealistic within a foreseeable future. Some innovative solutions must be found to coup with this critical problem. Chinese energy experts have developed and implemented a scientific energy policy that basically solved all the above seemingly formidable problems. The outcomes are encouraging. The statistics in Table 4 demonstrate the success of achieving the goal of "Quadrupling the GNP with Doubling the Energy Supply" within 15 years instead of the original schedule of 20 years. The major experience will be briefly described below.

Table 4. Energy consumption and elasticity in the PRC

Year		1980	1985	1990	1994
Gross domestic product (GDP)*	Billion RMB	541.78	899.46	1854.47	4491.80
	% of 1980 Value	100.00	166.29	242.67	384.66
Energy Consumption	Million tce	602.75	766.82	897.03	1227.37
	% of 1980 Value	100.00	127.22	163.75	203.63
Energy Intensity	tce/10^4RMB**	13.34	10.21	9.00	7.06
	% pf 1980 Value	100.00	76.50	67.48	52.93
Energy Elasticity***	.	NA	0.47	0.64	0.46

* Absolute value in this table are based on current price; percentages are based on comparable prices
** Based on 1980 RMB value
*** Average value of past 5 years

3.2 Independent Energy Study and Integral Energy Planning

In order to solve such a complex and difficult energy problem, Chinese experts carried out an independent energy study and an integral energy planning first. Based on their own bitter ordeal that energy policies had been made by Party Leaders through "patting their heads," Chinese energy experts firmly believe that no policy could be effective unless it is based on a sound, objective, and scientific basis.

Extensive energy studies were carried out by China Energy Research Society, an academic organization without any Department or interest bias. As a consequence, objective conclusions were drawn and effective measures were recommended. A comprehensiveintegral energy planning was then conducted and related policy recommendations made. On this basis, the first official Chinese Energy Policy was promulgated in a White Paper Document issued by the State Science and Technology Commission in 1983.

Various energy-economy-environmental models have been developed as tools for planning purposes. These include the national energy-economic model (by Tianjing University), the medium- and long-term energy forecast model, the rural economy-energy-environmental model (both by Tsinghua University), the energy flow analysis model (jointly by Tsinghua University and CEC), and others. Most of these models have been accepted by State Planning Commission and actually used in both national and provincial level.

3.3 The Comprehensive Energy Conservation Program

The reduction of energy elasticity from 1.66 down to 0.5 is by no means an easy task. Chinese energy experts solve this problem with the following approaches:

(a) In-depth analyses of energy conservation potential

Chinese experts first analyzed the reasons responsible for high energy intensity in many industrial and domestic sectors. They identified the structural factors, i.e., the sectoral, branches, and product-mix level of energy intensity. Then they looked for the technology factor, i.e., the energy intensities of alternative technologies for each product. Finally they investigated the management factor to identify all the managerial activities that effect the energy intensity of a sector or a product. Multiple case studies have been performed. The energy conservation potentials were thus evaluated and realistic recommendations have beenmade.

(b) Adjustment of Economic Structure

Adjustment of economic structure toward a less energy-intensive economy, including the adjustment of the relative shares of various sectors and changing the product-mix within each sector. For instance, the service sector should be developed faster than industrial sectors, and the light industrial sector faster than heavy industries. Within each sector, deep processing or refining of products should be encouraged in order to create more value from the same amount of energy or raw material consumed.

(c) Management Improvement

Improvement in management, including the establishment of a hierarchy of energy management, assigning responsibilities and authority,setting up energy audits and accounting systems, promulgating energy conservation norms and regulations, implementing energy conservation programs, preparing energy conservation planning, and using rewards and penalties to achieve goals.

(d) Economic Measures

Use of incentives and economic measures, including the gradually deregulation of energy prices and the provision of energy conservation investments, loans, and subsidies.

In Table 5, a statistics of the energy savings from 1981-1987 is shown. It is noted that a total energy saving of over 1 billion tce has been achieved. Taking into consideration of the accumulative effect of this achievement, the success of Chinese comprehensive energy conservation policy is obvious.

Table 5. Chinese energy saving, 1981-1987

Year	1980	1981	1982	1983	1984	1985	1986	1987	Total
GDP (10^9 US$)	245.9	257.9	286.0	306.7	348.1	393.9	424.7	464.4	2481.7
Energy Consumption (kgce/US$)	602.8	594.5	626.5	660.4	709.0	770.2	880.8	845.0	5014.4
Energy Intensity (kgce/US$)	2.451	2.305	2.191	2.153	2.307	1.955	1.904	1.820	2.021
Annual Energy Saving (Mtce)	...	37.6	74.5	91.3	144.2	195.2	232.1	293.2	1.068.1

3.4 Fast Growing of Energy Production — Walking on Two Legs

In view of the tremendous scale and the complexity nature of the Chinese energy problem, the key to the Integral Energy Planning is "walking on two legs." This policy emphasizes both energy conservation and energy provision; both commercial and traditional energy; both conventional and new commercial energy; both demand- and supply-end management; both domestic and foreign involvements; and both hard- and soft-science approaches.

In order to double the provision of commercial energy within two decades (actually accomplished in 15 years), "walking on two legs" policy is most effective. The domestic primary energy production reached 1,187 Million tce, or 186% of the production in 1980. The growth of total primary energy production is shown in Table 6.

Table 6. The domestic primary energy production of the PRC

Year	1980	1985	1990	1994
Total Energy Production (Million tce)	637.35	855.46	1039.22	1187.29
Share of various products, % of total				
Coal	69.4	72.8	74.2	74.6
Oil	23.8	20.9	19.0	17.6
Gas	3.0	2.0	2.0	2.0
Hydro	3.8	4.3	4.8	5.8

It is noted that the share of coal increased steadily while that of oil decreased. The share of hydropower also increased; however, its share is small as compared with coal and oil. The rapid increase of coal production relied heavily on the "two-leg" policy. The share of coal production from the state-owned coal mines decreased from 56.48 in 1980 to 44.29 in 1988, and 75% of the 360 increment coal supply from 1980 to 1988 was delivered by locally-owned

small coal mines.

Another example of the "two-leg" policy is the power sector. The growth rate of the power sector was higher than total energy sector, and basically matched that of theeconomy. Formerly all the investment in the power sector came from the state budget. It is impossible to triple this budget to meet the requirements of power plant construction. The only solution is to rely on another "leg," that is, to raise capital from other sources. This policy implemented very effectively.

In 1980, the state provided nearly 99% of the total capital for the power sector. But in 1988, the total investment increased 600%, of which 60% was provided by other sources.

3.5 The Comprehensive Rural Energy Program

China has successfully solved at least the basic rural energy problem by implementing a comprehensive rural energy program. Very detailed investigation of Chinese rural energy sources and energy situation were conducted, and integral planning on national, provincial, county (typical), and village (typical) levels were performed. The implementation of rural energy program was conducted at the local level, but closely monitored and effectively assisted by the central and provincial governments. The general rural energy policy was that the rural energy supply should be "in-line with local conditions, supplementing various energies mutually, utilizing resources comprehensively, and emphasizing economic benefits." This policy has been implemented with great success. Some major elements and achievements of this program follow.

(a) Development and dissemination of Fuel-Saving Stoves

The most successful rural energy program in China, maybe also in the world, is the development and dissemination of over 100 million fuel-saving stoves in the pastdecade. An overview of the fuel stove program is shown in Table 7. This achievement is particular impressive because it has been accomplished in a vast countryside with one billion people living in a great variety of geographic and mythological conditions. Such an experience has attracted the attention of international energy community and has been widely discussed all over the world. The detailed experience of this program has been described in many articles. In short, it is the result of a correct policy and correct approach; these are the two key factors leading to the success.

Table 7. Chinese national and provincial fuel-saving stove programs (million household)

Year	1983	1984	1985	1986	1987	1988	1989	Total
National pilot countries	90	200	100	97	101	96	51	735
National program (million)	2.6	11.0	8.4	9.9	8.9	10.0	9.9	60.7
Provincial program (million)	4.0	9.7	9.5	8.5	9.1	7.5	5.0	53.3
Total household (million)	6.6	20.7	17.9	18.4	18.0	17.5	14.9	114.0*

* By the end of 1990, the total number increased to 120 million; and by early 1992, 129 million

(b) Increase of Firewood Supply by Afforestation

A campaign of afforestation began in 1980. The new policy advocating the private ownership of small wood lots and trees around houses was enthusiastically received by the peasants. About 6 million hectares of firewood was plant under the Sixth Five-Year Plan, corresponding to about one-fifth of the previous barren hills and slopes available for afforestation. More afforestation campaign have been implemented in the following Five-Year Plans.

(c) Minihydropower and Rural Electrification

One principle of the Chinese rural energy policy is to utilize local energy sources as far as possible. In many mountainous regions with ample annual rainfall, minihydropower is considered a natural endowment for rural energy. China has developed cheap and reliable equipment for minihydropower generation. In the year of 1989, minihydropower in Chinese countryside amounted to 50,862 stations with a total capacity of 4,168 GWe, and supplied about 13% of the total rural electricity.

China has launched a rural electrification program with a three stage approach. In the preliminary stage, 90% of all the household in a given county will have electricity and the annual per capita power consumption will reach 200 kwh. In the second stage, 95% of the total household in a given county will have electricity and the per capita consumption reach 400 kwh. The final stage is the comprehensive electrification of all household in a given county. One hundred counties have been selected for the first stage demonstrative program, and most of them have achieved the goal in 1990.

This program has been implemented with great success.

(d) Biogas Program

The Chinese biogas program has experienced ups and downs, and is considered not so successful as the other rural energy programs. Only 7.5 million biogasdigester werebuilt in 1990, as compared with 120 million fuel-saving stoves. The major reasons are the complexity of the biotechnical process and the limitation of climate and feedstocks. However, biogas program is considered a comprehensive energy-sanitation program in rural region, and will continue in a moderate scale.

4.0 Conclusion

The success Chinese energy policy in fueling 1.2 billion people and the quadrupling GNP within 15 years has demonstrated the power of the truly scientific policies and the effective implementation of such policies. The development and implementation of such a policy require adequate political and social climates. However, tremendous efforts and sacrifice have been made, and these are the decisive factors. Based on their own experience, the Chinese energy community firmly believe in a Chinese proverb: "Although the road to success is tortuous, the future of mankind is always bright."

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The Tehri dam project and issues of population, development and environment

Submitted by
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The Tehri dam project and issues of population, development and environment

[1]Ashish Bose

Genesis

The continuing controversy over the Tehri Dam Hydro Power project in Western Himalayas, for the last two decades and recent events like stalling of the project after the 49 day hunger strike was called off by Sunderlal Bahuguna, the environmental ist, in the light of the Prime Ministers assurance to review the project, qualify the Tehri Dam Project as a case study worthy of presentation to an international conference on population, envi ronment and development. The Tehri Dam project has important lessons for engineers and environmentalists, not only in India but throughout the world, and planners and policy makers can be cautioned about the hazards of going ahead with technology in disregard of socio-cultural factors. In our view, the total reliance on engineering aspects has made this project an example of arrogance of technology combined with socio-cultural insensi tivity in the Himalayas. There is also an element of over-reli ance on Soviet technology of building earthquake-proof dams in seismic zones. Our field work shows that the innocent hill people trust God more than Soviet engineers!

A power engineer is not the best person to appreciate the deep reverence for rivers in India, nor is a worshipper of Bha girathi which mythology says originated from the matted hair of Lord Shiva, and culminated in the holy Ganges (Ganga), the best person to accept the assertion of the engineers that the Tehri Dam has been "designed to withstand a maximum earthquake of the magnitude of 7.0 on the Richter scale, with an epicentre of 27 km from the Dam site." The engineer goes by 'scientific' data while the worshipper of the sacred river quotes scriptures and mytho logy. In comes the environmentalist who respects both science and Nature and we get into the world of 'environmental impact' re ports. Then comes the social activist who speaks up for the people who are rarely consulted in matters of various ongoing developmental projects. The social activists give voice to the voiceless and agitations start. Big dams require big money. In comes the World Bank and other donor agencies, as well as foreign experts of all hues. The World Bank and the donors are not ex pected to have a direct dialogue with the people. In comes the bureaucrat along with his masters-the politicians, in particular, the concerned Ministers (for irrigation/power/environment), and even the Prime Minister. The drama gets more and more intricate. The media gets into the

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resistance. The Government responds by agreeing to appoint one more review committee. There is temporary peace which often means a lull before the storm.

I am grateful to the President and Vice President of Tata Energy Research Institute and the co-sponsors of this conference for giving me an opportunity to present this case study, based on my field work with the people and discussion with a wide range of persons in New Delhi as well as in the project area. I have also gone through a lot of material, published and unpublished, on this controversial project. Above all, I had the opportunity of several meetings with Mr. Sunderlal Bahuguna, an environmentalist and social activist of international fame, who has been relentlessly opposing the Tehri Dam Project for about two dec ades. I was the first person to meet him when he broke his fast unto death on the banks of Bhagirathi river near the Dam site on June 27, 1995, after an assurance from the Prime Minister con veyed through the Governor of Uttar Pradesh.

As a demographer interested in policy research (Bose, 1994, 1996), I got interested in the subject of distress migration, in particular, migration of 'oustees' or people whose land and houses would be submerged when the Dam comes up. The entire Tehri town would be wiped out and this was good enough for me to take up a study on the fate of more than 20,000 persons in this old town (apart from thousands of oustees from adjoining villages which would be submerged). I did see the new township which has been built — New Tehri — but it was a sad example of poor town planning and betrayed a lack of understanding of the issues of population, environment and development. I am all for new towns (I was a member of the National Commission on Urbanisation which submitted its report to the Prime Minister in 1988) and I was responsible for coining the acronym - GEM - Generators of Econom ic Momentum and pleaded for the development of 329 GEMs all over India. I saw no evidence in New Tehri of its potential for emerg ing as a GEM. The most impressive aspect of New Tehri is the spacious Jail from where one gets a magnificent view of the surrounding hills, if one is not chained in the prison rooms!

Historical Background

For those not aware of the Tehri Dam Project, I may give a very brief historical background. In order to augment the supply of water for irrigation and agricultural development and elec tricity for increasing industrialisation, soon after Independence (1947), the Government thought of hydro-power generation in a big way and started thinking about big dams. Bhakra-Nangal Dam became a reality in course of time and played a big role in India's green revolution in Punjab, Haryana and Western Uttar Pradesh. A big dam was contemplated in the Tehri Garhwal region of Western Himalayas in Uttar Pradesh. In 1972 the Tehri Dam project was officially approved (see Appendix A for details of location). A 260.5 m rock filled dam was to be built below the confluence of Bhagirathi and Bhilangana rivers in order to generate 600 MW of electricity. Later, the plan was revised and the installed capac ity was

raised to 2400 MW. Administrative clearance was given in 1976. Soon after, the agitation against the dam, led by Sunderlal Bahuguna started. The agitation is still on the dam project has been hibernating for the last 20 years, Several committee were appointed to look after different aspects of the Dam. (For an elucidation of the viewpoint of opponents of the Dam, see Appendixes C, D and E).

Of particular relevance in our discussion is the report on Environmental Appraisal of the Multi-purpose Tehri Dam Project (1990) prepared by a technical Committee under the Chairmanships of Dr. D. R. Bhumbla, a noted agricultural scientist. The Commit tee concluded (for details see Appendix B):

"Taking into consideration the geological and seismic setting, the risks & hazards, ecological and social impacts accompanying the project, the costs and benefits expected; and after a careful examination of the information and data available, the Committee has come to the unanimous conclusion that the Tehri Dam Project, as proposed, should not be taken up as it does not merit environmental clearance". **(Bhumbla, 1990: 10).**

Earlier, Indira Gandhi's Government had set up another Working Group under the Chairmanship of Mr. S. K. Roy, an envi ronmental expert, A draft report was prepared but it was alleged that adequate data were not collected and the Government tried to suppress the inconvenient views of some experts. Mr. Roy reject ed the report in 1986 and opposed the Dam on account of "known instability of the hillsides, the extensive deforestation and the location of the Tehri Dam in a highly sensitive seismic zone" (Kutty, 1994: 126).

In 1987, there was a dramatic development when President Mikhail Gorbachev visited India. According to K. Govindan Kutty, the biographer of T. N. Seshan (who was then the Secretary of the Ministry of Environment and Forests, and currently, the high- profile Chief Election Commissioner of India), Gorbachev wanted to announce something spectacular by way of Indo-Soviet co-operation. The Tehri Dam project was selected for Indo-Soviet co-operation involving technical and financial assistance for the project from Soviet Union. To overcome fears about destruction of the dam by an earthquake, it was pointed out that Soviet experi ence of dam construction - the Nurek dam and Rogu dam in Central Asia's seismic zone - would ensure the safety of the Tehri Dam. Kutty devotes a whole chapter ('Green Concerns') to Seshan's sad experience in regard to the Tehri Dam project.

It seems that Seshan opposed the project. As a result, he was kept out of the high level meeting which finalised the deal with the Soviets. Kutty observes that the decision regarding the Tehri Dam was taken "in the name of diplomatic exigency" He continues:

"Tehri dam had a hoary history. Civil engineers and contractors had painted verdant pictures of sprawling fields which could be watered when the dam was built. Projections of

farm production were striking. The effort was to create a colourful illusion of development by employing the magic of statistics. The gains of Tehri seemed overwhelming when presented through the poetry of civil engineering and the politics of works contract". **(Kutty: 125)**

Kutty says that when Seshan heard that the Tehri Dam was finally cleared, he sat back in his chair, tilting his head backwards and mentally recited his favourite lines from Gita: "You have a right to work only, not its fruit". (Kutty: 127-128).

Kutty also records that "Like Soviet aid was available for Tehri, America had promised 600 million dollars for the Bodhghat project in Bastar in Madhya Pradesh" which Seshan opposed and the Prime Minister (Rajiv Gandhi) concurred with his views and the project was off.

In passing, we may point out that in 1993, the Government of India appointed a committee for reviewing the Bodhghat Hydro- electric project in Bastar district, headed by the M. N. Buch, an outstanding administrator and environmentalist. The Committee concluded as follows: .ls 1

"The Bodhghat project is ill-conceived in that for a minor quantity of power a very diverse, dense and rich forest will be permanently destroyed. Ecologically the project would be a disaster, because in its conceptualisation it has fully ignored environmental importance of water, vegetation and forest fauna, while at the same time completely overlooking a vital element of the ecosystem, man. the entire riverine system of the Indravati River will be disturbed and the forests of Central Bastar brought under considerable threat and human habitation ruined. Under these circumstances the Committee strongly recommends that:

"1. Environmental clearance be refused to the Bodhghat project and any earlier clearance be cancelled.

2. Suitable directions be issued to the Madhya Pradesh government to take necessary steps to protect the forests of Bodhghat in particular and Central Bastar in general. This would include the carrying out of silvicultural operations in the pine plantation area, which is now showing signs of reverting to the original forest.

3. A very serious view be taken of the proposed projects at Kulru, Nugur and Bhopalpatnam especially in the light of the observations of the committee on the Indravati river as a whole.

4. The chapter of the Bodhghat project be firmly and finally closed". **(Buch, 1993: 18).**

Big Dams Versus Small Dams

K. S. Valdiya, an eminent geologist, currently at the Jawa harlal Nehru Centre for Advanced Scientific Research, Bangalore, opposes big dams and in particular, the Tehri Dam project. To quote him at length:

"The analysis of the Planning Commission figures by S. Singh (1993) demonstrates that it costs over Rs. 2,800 to provide irrigation to one hectare of land through major/medium irrigation schemes compared to just Rs.840 for an equal area by ground-water schemes. It is, however, true that the cost of production of electricity is high for small hydel schemes - Rs. 15,000 to 8,000 per KW compared to Rs. 7,000 to 3,000 per KW by large hydel projects (S. Singh, 1993). However, if one thinks of the real (total) cost of water resource development projects which also includes the environmental and resource losses, the cost of damaged land and the enormous expenditure on the relocation of uprooted communities of people, this high cost of electricity by small hydel schemes is more than compensated". **(Valdiya, 1996:42)**

B. D. Dhawan, an irrigation economist started a debate on big dams with his article on 'Mounting antagonism towards big dams' published in **Economic and Political Weekly** (1989). A series of papers published on this controversial subject by different authors was brought together by Dhawan in a book edited by him - **Big Dams: Claims, Counter-Claims** (1990). Dhawan examines various aspects of the cost of major and minor irrigation works and concludes that "the case for according priority to minor irriga tion development in India's water planning on grounds of cost economy is not well founded in facts". (Dhawan, 1990: 125). A young economist, Ashok K. Mitra criticise Dhawan's methodology and maintains that "the rent-seeking elements (i.e. kickbacks and fictitious expenditure) which are to be excluded from total cost would be peanuts before the real resource cost in terms of land submerged and the loss of forest by major irrigation works and to this if we add real resource cost of rehabilitation of the displaced households, the real resource cost would appear to be phenomenal" (Dhawan: 142). In his reply to this criticism, Dhawan says: "To what extent future empirical investigations will falsify my assertion in favour of major irrigation has yet to be seen. **Even if these are proved false, no serious policy changes in water planning would arise**". (Dhawan: 148)

Dhawan goes on to clarify his advocacy of big dams by point ing out that he has no vested interests and it would be unfair to condemn him as a lobbyist for big dams . Kanchan Chopra, an economist, in her contribution on 'large dams and cost-benefit analysis' is more theoretical in her approach. Of particular relevance to us is the discussion on the Tehri Dam based on a series of technical reports prepared by the Tehri Dam Project Authority (1969, 1983, 1986) and V. Paranjapye's study on 'Evalu ating the Tehri Dam: An Extended cost-benefit appraisal (1988).

Kanchan Chopra takes a critical view of both the official reports on the Tehri Dam as well as Paranjapye's analysis. She calculates the benefit-cost ratio using UNIDO methodology and concludes that "the project continues to be not viable even after the UNIDO methodology has been followed". (Dhawan: 189)

Reverence for Sacred Rivers

It would be manifestly wrong to confine the discussion on Tehri Dam to benefit-cost ratios worked out by economists, no matter how much concern the economists show for social cost. The socio-cultural aspect cannot be relegated to the back seat. The Indian reverence for rivers and mountains can no more be treated as superstition by the uninformed Westerners who are only lately grasping the significance of religion and philosophy in an era of growing concern for environment and ecology. In any people-cen tred development programme, the perception of the people assumes paramount importance. Unfortunately there is no socio-cultural study of the Tehri Dam Project. For the controversial Narmada Valley Project (Sandar Sarovar Project), there is a recent socio logical study by a scholar-activist, Amita Baviskar: In the Belly of the River (1995), where she deals with tribal conflicts over developments in the Narmada valley. She begins her book with a quotation from Kashinath Trivedi who says: "It is the dharma of a river to keep flowing". (Baviskar, 1995: v).

During our field work in the Tehri Dam affected villages, we were constantly reminded about the free flow of water in the Bhagirathi leading to Ganges, the most sacred of all rivers. Sunderlal Bahuguna in a recent article on the 'Plight of Bhagira thi' (Hindustan Times, 18 February, 1996) tells us that Madan Mohan Malviya, the great nationalist, had organised a powerful movement during 1914-16 when there was a proposal to divert Ganges water to a canal. On his deathbed Malviya sought a promise from Justice Shiv Nath Katju saying: ".....I have called you to promise that you will raise your voice against any plan to ob struct the free flow of the Ganga". Bahuguna quotes a contempo rary revolutionary from Bengal (Pannalal Babu) who says: "Ganga is not a river. She is our life : Tampering with the Ganga is piercing our heart". He is opposed to the Tehri Dam Project.

It is worth recalling that one of the very first projects announced by Rajiv Gandhi when he became Prime Minister was to clear up Ganga but as Bahuguna points out, "the project fell victim to corruption and mismanagement". (Bahuguna, 1996).

The whole controversy about the Tehri Dam Project must be viewed in the wider context of culture and religion woven into ecology and environment. As Bahuguna told me: "I fighting to save Ganga and Himalaya". (Bahuguna: 27 June, 1995)

A major cause of opposition to the Tehri Project is the fear of earthquakes. The earthquake in the neighbouring district of Uttarkashi in 1990 shattered the confidence of the common man in engineers who have assured that the Tehri Dam would be earthquake proof. Much of this technical confidence in engineering skills is dubbed as arrogance of technology.

The people in that region would any day put more faith in God than engineers, Russian or Indian! It is contended that an earthquake or a dam burst would completely devastate the holy cities of Rishikesh and Hardwar. What is at stake, therefore, is the foundation of religion and it is not merely a matter of irrigation or electricity. Nobody denies the great need for augmenting the supply of water and electricity but is building big dams the only way to generate electricity or develop irrigation?

A scientist from the Ministry of Environment told me: "we are neither for nor against big dams. Each case must be examined on its own merits." But are irrigation and power engineers the only persons whose verdict should be final? Is life governed by benefit-cost ratios? Whose cost and whose benefit?

In a field study on the reconstruction of life by the oustees of the big Hirakud Dam Project in Orissa, Balgovind Baboo, a social anthropologist in his book on Technology and Social Transformation concludes:

"The mad rush for multi-purpose dams like the Hirakud dam must be stopped at the earliest. The forces of Nature must be curbed as little as possible so that man becomes its friend and not its foe" **(Babu 1991: 140).**

Babu dedicates his book to his father "who marvelled at the positive aspects of the Hirakud dam without knowing its long term nuances and social costs". Baboo's study reveals that "the dam has failed in its major objectives like electricity, irrigation, flood control and enhanced agricultural production" (Baboo: 149).

Lack of Adequate Studies and Data

I had the benefit of detailed discussion with a distin guished social anthropologist - B. K. Roy Burman who was a member of the Bhumbla Committee on Environmental Appraisal of the Tehri Dam Project. He expressed his indignation at the way the Project authorities tried to mislead the Committee by taking them round some 'show-piece' villages where the dam oustees were resettled but when the Committee members paid unscheduled visits to some other villagers, they got a bleak picture of resettlement from the oustees. Roy Burman (1996) who is fully conversant with the developments of the Tehri Dam project feels that in the absence of adequate data, it is not possible to take a stand on the controversial dam issue. He endorses what the Bhumbla Committee said in its report.

"Unfortunately, no study has been done on the ecological impact of all these projects on the river, on its water quality, its flora and fauna, and its ability to survive as an eco-system" (Bhumbla: 7).

Our quick field study in the Tehri Project area reveals a mixed picture of the oustees. For example, there are several families in the old Tehri town who have already collected their compensation money and also got land in exchange of their proper ty which would be submerged but as Tehri town still remains intact they lost nothing but gained in this process.

My local investigator reported that there were several cases of corruption on the part of members of joint families who claimed the whole house as their individual property and in this process, multiple compensation money was paid for the same property. On the other hand, there were frequent complaints against the officials of the project who were accused of widespread corruption. There is no doubt that in a project involving massive investment, there is considerable scope for corruption at all levels. Engineers, contractors, bureaucrats and politicians are all in the game and when they collude, the people suffer. Most of these persons have utter contempt for social activists like Sunderlal Bahuguna. It is worth recalling that U.P. Government tried to suppress the Tehri agitation ruthlessly; Sunderlal Bahuguna was arrested and sent to a New Delhi hospital. The Court came to his rescue. He continued his fast unto death till the Prime Minister sent him an assurance through the Governor of U.P. that the Dam Project would be reviewed again but nothing concrete has been done ever since he broke his fast. Our assessment of the field situation is that there is every possibility of the Tehri Dam resistance movement getting hooked to the movement for a separate Uttarakhand State which is gathering momentum. The vested political interests who are clinging to the mega state of Uttar Pradesh (whose population is more than that of Bangladesh or Pakistan) will find it very difficult to resist the demand for Uttarakhand in the coming election. People's power will ultimately assert itself. India's vibrant democracy and powerful Supreme Court will sooner or later bring justice to the common people.

Demand for a New State

The Tehri Dam Project should also be examined in the light of the political agitation for a separate state comprising the hill district of U.P called Uttarakhand. The hill people are convinced that their future is bleak in the huge state of Uttar Pradesh with population of 119 million persons spread over 63 districts, unless a smaller state is carved out which develops the natural and human resources in the hills, unfettered by the governance from Lucknow - the capital of U.P. It is worth recall ing the high handedness of the U.P. Government in forcibly ob structing the agitators from Uttarakhand, came in for severe criticism from the Supreme Court which awarded hefty compensation to the persons affected and their kin and also to the women who were molested by the police. A leading scientist from this region - Dr. Valdiya - has opposed the Tehri Dam on technical grounds.

The most balanced contribution to the Tehri dam literature, to our mind, is by Jayanta Bandopadhyay, a noted environmentalist who presented a paper on the subject at the Stockholm Water Symposium (August 1995). An abridged version was published in **Economic and Political Weekly** (23 September 1993) under the title: 'Sustainability of Big Dams in Himalayas,' Bandopadhyay observes:

"It should go the credit of the Anti-Tehri Dam Committee and the Gandhian social activist Sunderlal Bahuguna that the environmental impact assessment of the proposed dam was started in 1980, and subsequently improved years. In contrast the scientific community of India except a few exception had hardly shown any early or independent professional interest in the issue so significant for the growth of science and the society in India" **(EPW: 2367)**

Elaborating the policy implications of a big dam like Tehri not only for India but for other countries as well, Bandopadhyay says:

"The progress of the debate on the Tehri Dam will definitely act as a guideline for future decision making in the case of other big dams proposed in the Himalaya. For countries like Nepal and Bhutan, water resource is the most important natural resource from the viewpoint of economics. The focusing of the debate on the seismic risks may extend the debate to a new dimension of upstream-downstream conflict in the region. When both the upstream and downstream areas of the dam fall within one northern- state, as in the case of Tehri, the decision-making process is often influenced more by the economic growth factors at the cost of social and environmental damage factors. However, when the upstream and the downstream areas fall in two different countries, as will be the case for dams all along the southern border of Nepal and Bhutan, this will not be the case. Under this situation, the question of dam safety will then be addressed singularly by the downstream country and governed by international law. This will create an additional factor for the downstream country to influence decisions in the upstream country. Since all the future water management projects will have to depend on the question of storage, the present uncertainties related to the seismic risk from large dams in the Himalaya need to be addressed at the earliest. Otherwise there is a strong possibility that dam issues may become subject of international litigation." **(EPW: 2369)**

The author concludes: 'Himalayan water need not for ever be considered by the downstream plains as a free gift brought in from the upstream areas by colonial laws used by the state': (EPW: 2370)

Conclusion:

On the basis of our field work on the Tehri Dam Project area and our interaction with the authorities, engineers and environmentalists and more importantly, **the common people** and

also on the basis of our perusal of the literature (including newspaper articles and editorials), we may sum up the situation as follows:

Soon after Independence, Indian planners and policymakers thought in a big way of harnessing river waters through big dams in order to provide increasing irrigation for agricultural devel opment and electricity for industrial development. One technocrat Minister (Dr. K.L. Rao) was responsible for putting forward an ambitious plan of linking rivers and developing river valley projects. In those days, neither India nor the world was environ ment-conscious. The idea of constructing a dam in Western Hima layan region (Tehri Dam) was put out in good faith. Likewise, the involvement of Soviet expertise in building big dams in seismic zones was also done in good faith. Similarly, the resist ance to the dam by environmentalists like Sunderlal Bahuguna was motivated by genuine ecological concern and the welfare of the poor people in the hills. In the face of controversy, the Govern ment of India did what is always done in India - appoint Commit tee after Committee to examine the pertinent issues. There is no evidence to suggest that members of various Committees were not objective in their assessment. Finally, the innocent people of the hills cannot be faulted for their genuine apprehension about a possible earthquake and a dam burst wiping out the priceless cultural heritage of India reflected in sacred towns of Haridwar and Rishikesh. Then why this impasse about the Tehri Dam project?

If one were to accept the narration of the sequence of events in T.N. Seshan's biography, one would have to concede that political expediency and diplomacy did influence Rajiv Gandhi government's decision not to abandon the project but not enough concern was shown for the viewpoint of the people in the affected region nor for vital socio-cultural factors. Prime Minister Narasimha Rao in his characteristic style maintained the status quo and there is hardly any progress in constructing the dam nor has the project been abandoned. His assurance to Sunderlal Bahu guna to review the project was interpreted (after Bahuguna broke his fast) to mean that only <u>new</u> issues would the examined and the bureaucrats declared that there were no new issues. So the stale mate continues. Meanwhile, the allegations of corruption against the project authorities have increased, much of which may be true in the light of recent revelations about corruption in high places.

What should we do about the Tehri Dam Project? In our view the decision regarding the project must take note of the follow ing imperatives:

There should be no room for arrogance of technology. Socio-cultural factors are equally important and cannot be written off as superstition. Reverence for rivers and mountains is sound ecology and good economics, which Westerners are only lately realising. It is generally accepted that in any benefit-cost analysis, social cost also should be adequately noted but what about **cultural** cost? Can one write off the pervading impact of **religion** on the daily lives of people? What about the **political** cost? How long can India be run from New Delhi and U.P. from Lucknow? Is assertion of regional identitity the same as lack of

patriotism? Certainly not. Uttarakhand as a separate State is bound to become a reality. The Tehri Dam Project will not be uncritically accepted by the Government of this new State. One must, therefore, face political reality and not rush with the Tehri Dam Project. Of late, corruption has become a major election issue. It is a fact that contractors and specially big contractors indulge in corruption with the connivance of politi cians and bureaucrats. If the Supreme Court continues to take a tough stand, the level of corruption is bound to come down. In such a situation, the oustees in the Tehri Dam Prject area may agree to accept a realistic and viable rehabilitation plan for their resettlement in new areas. India has enough expertise to tackle engineering problems in regard to the height of the dam, earthquake proof technology and related technical issues. There is very little need for foreign experts or even for foreign funding for such a project. Technology cannot succeed in a social vacuum and technocrats should not be ignorant of Indian values and cultural norms. The sacredness of Ganga must be respected and the cleaning of Ganga must not be sabotaged by corrupt officers and contractors. The Himalayas must be saved, the forest must be preserved and human beings must live in harmony with Nature. These are not platitudes but imperatives for the 21st century. At the same time, one should not take a romantic view of environment and oppose all developmental projects.

A leftist economist in India asked me: "The Bhopal gas tragedy was the worst industrial accident in the world. Why are there no social movements espousing the cause of the victims of this tragedy?" He suspects that some developed countries in the West invariably oppose bold irrigation and agricultural development plans in countries like India because they want to safeguard their own agricultural exports. He went to the extent of chal lenging the credentials of most social activists opposing big dams who, according to him, find more inspiration abroad than in India. This economist may be right but as far as the Tehri Dam Project is concerned, we did not find any evidence of social activists playing into the hands of vested interests and foreign lobbies. Development must be centred round people. In a democra cy, the whole development process must be participatory in na ture. Furthermore, in the name of science and technology, devel opment should not be culturally insensitive.

When one takes up projects like the Tehri Dam in a seismic zone, there should be detailed planning for disaster management - natural disasters as well as manmade disasters.

Finally, we would plead that our is not just another case study of a big dam project but has wider national and interna tional implications for donors, planners and policy makers. In spite of several Committee appointed from time to time, we have not developed in a systematic way, a scientific body of infor mation on the complex issues involved. It would be manifestly wrong to confine such data only to the engineering aspects of generation of energy. The people must have priority and, there fore, social science data are vital. We humbly suggest that the House of Tatas should set up a new organisation called CRESTT - **Centre for Research on Environment, Social Transformation and Technology**. The best

place to locate such a Centre would be in the Himalayan heights in Uttarakhand. Technology and social transformation must progress hand in hand to improve the quality of life of the common people.

Appendix A

The Project Area

Situation:

The Tehri dam catchment project area lies in Garhwal hills of Central Himalayas in Uttarkashi and Tehri districts of Uttarkashi and Tehri districts of Uttar Pradesh. It extends from 30^0 15'30" N to 31^0 15'N Latitude and from 78^{0}0'0" E Longitude. It covers catchment of river Bhagirathi and Bhilangana. The area of the project is 6921.25 sq. kms. It is roughly 0.56 of the total area of Tehri and Uttarkashi districts. More than 25% of the area remain covered under perpetual snow.

Table 2.1

Districts	Total geographical area (sq. km.)	Area under the Project (sq.km)
Uttarkashi	8016.00	5229.87
Tehri	4421.00	1791.38
Total	12437.00	6921.25

The project area is bounded by various subwatersheds as under

North - Himachal Pradesh and China
East - Sanswat, Mandakini & Guptakashi
South - South Bhagirathi, Badiyargad and Dangchaoura
West - Yamuna catchment

Source : Tehri Hydro Development Corporation Ltd., Environmental Action Plan, Volume I, Catchment Area Treatment Plan, (Integrated Water Shed Management Project) Report prepared by Land Survey Directorate Forest Department, Dehradun, U.P., 1990

Appendix B

Excerpts from the Bhumbla Committee on Environmental Appraisal of the Tehri Dam Project, 15 February, 1990

"ENVIRONMENTAL ASSESSMENT OF THE TEHRI DAM PROJECT

1. From a study of the Tehri Dam Project, as proposed, it became clear to the Committee that the decision on its environmental viability and optimality would depend on the following factors:

1.1. The ability of the dam structure, as designed, to withstand the maximum credible earthquake that can be expected in the region during the anticipated life of the project.

1.2. The ability of the hillsides and reservoir rime, in the project area, to withstand such an earthquake.

1.3. The implications of dam failure on life and property downstream.

1.4. The rehabilitation package being offered to the oustees, in terms of what is proposed and how well it has been implemented so far.

1.5. The ecological damage that the project would cause, and the planning and implementation of preventive and mitigative measures.

1.6 The costs and benefits of the project, especially in terms of adequate financial provisions for all the issues listed above, and keeping in mind the need to ensure that the benefits anticipated are realisable. It must also be ensured that the benefits go to deserving sections of the society, especially to those regions and individuals who are being negatively affected by the project, and justify the non-quantifiable social and ecological costs that all such projects inevitably have.

Our findings and recommendations regarding these points are given below.

2. **A seismic Design of the Dam**: The project authorities, and experts from the Central Water commission, all assured the Committee that the Dam has been designed to withstand a maximum earthquake of the Magnitude of 7.0 on the Richter scale, with the epicentre 27 km from the Dam site.

The Committee did not examine this assertion in any great detail, for it considers the Magnitude of the earthquake, taken as the maximum credible one, **to be inadequate.**

The Committee is of the opinion that the maximum credible earthquake for which the Dam should be designed is M > 8.5 on the Richter scale, 27 kms. from the Dam site.

The Committee has come to this conclusion on the basis of discussions with various experts, including Dr. V. K. Gaur, Secretary, Department of Ocean Development, Government of India, and Dr. Harsh Gupta, Vice-Chancellor, Cochin University. The facts and arguments offered by these experts make the Committee believe that there is almost a certainty that, during the anticipated life of the project, an earthquake of the Magnitude of 8.0 and above would occur in the region.

The Committee is aware of the differing view points on this question, but is convinced that given the facts, the experience and stature of the experts consulted, and the horrific implications of a Dam failure, it would be irresponsible to clear the Tehri Dam, as it is currently proposed.

3. **Stability of the Rim and Hillsides:** The reservoir rim and hillsides have been tested, if at all, for an inadequate level of seismic level indicated. This is especially important because, if the hill-sides collapse due to an earthquake, the implications can be as bad as if the Dam collapsed.

4. **Implications of Dam Failure:** Though no risk analysis had been done by the project authorities, the Committee's calculations, albeit preliminary, showed that if the Dam collapsed, or was over topped due to collapse of the hillsides, the resultant water wave would wipe out Rishikesh and possibly Haridwar. The loss to life and property is incalculable, but can be imagined.

These calculations strengthen the thinking of the Committee that it would be very irresponsible to construct, at Tehri, a dam which is anything but safe. It also highlights the necessity to prepare a detailed Disaster Management plan, based on a risk assessment: something that has not yet been done.

5. **Rehabilitation:** The Committee noted that the rehabilitation package being proposed for the Tehri Project is inadequate, and much inferior to the accepted for other similar projects, like Sardar Sarovar in Gujarat.

The Committee also noted that planning and execution of the rehabilitation programme was very poor. The total number of people to be affected was in dispute, land to rehabilitate all those affected had still not been acquired, legal title for the land had not been transferred to even those shifted ten years back. Most of the land given to the oustees is sandy, stony and

of low productivity.

The condition of those shifted ten years back was apalling and did not augur well for those to be rehabilitated.

It is well recognised that unless planning, identification of land and provision of sufficient resources for rehabilitation is done before a project is cleared, it becomes very difficult to ensure that the people ousted by the project get justice.

The Committee, therefore, is convinced that the rehabilitation package should be improved, adequate and appropriate land identified, and sufficient provisions made for rehabilitation in the Project budget, before the project can be considered.

6. **Ecological Damage**: The damming of any river has significant ecological impacts. The damming of a hill river, and especially the Bhagirathi which already has three existing and proposed run- of-the-river projects, has even greater than normal ecological impacts.

Unfortunately, no study has been done on the ecological impact of all these projects on the river, on its water quality, its flora and fauna, and its ability to survive as an eco-system.

Considering the impact of ecological degradation of this riverine ecology will not only affect the local area, but will have an accumulative impact on the Ganga, there is even greater urgency to study and prevent this.

The Committee does not think that, in the absence of adequate studies and action plans on this aspect, the project merits environmental clearance.

7. **Cost Benefit Analysis**: Apart from the cost implications of the various recommendations made above, there are various other unresolved issues which need to be mentioned.

7.1 Catchment Area Treatment: Only 15% of the degraded catchment has been proposed for treatment. Considering the implications the state of the catchment has on the life and safety of the dam, and considering the very unstable state of Tehri Dam's catchment, the entire degraded portion of the catchment needs treatment, with a much higher financial outlay than presently proposed.

7.2 Siltation Rates: The current measurements of suspended and bed-load silt are not satisfactory. The committee anticipates that the actual rates of siltation would perhaps be higher, and certainly different, to what have been currently calculated. Therefore, the implications of this have to be considered on the life of the Dam, and on the resultant cost-benefit ratio.

7.3 Bhagirathi Development Authority: In conformity with the objective of achieving sustainable development in Bhagirathi Basin, the Committee reiterates the recommendation

that a **Basin Management Authority** must be set up so that professional inputs are available to devise and implement a project portfolio, within the carrying capacity of the basin, for its integrated development, and to maximise the flow of benefits to the local people. The Committee was informed that the formulation of such an authority had been mooted by the Ministry early in 1987 but it has not yet materialized. It is considered imperative that a Basin Management Authority dealing not just with the water resources but for the integrated development of this basin should be set up on priority, and its cost implications worked out.
7.4 Command Area development: Despite repeated requests, the committee was not provided details regarding releases of water from Koteshwar dam for utilisation in the command area, even though it is claimed that irrigation requirement would be governing such releases. In the absence of these details, it is not clear whether the releases would be governed by the requirement of power generation, or irrigation or both.

An area of 2.7 lakh ha. is proposed to be irrigated in the existing command of Upper Ganga, Lower Ganga and Madhya Ganga canal systems. In view of the substantial rainfall supplemented by surface and ground irrigation in the Upper and Madhya Ganga canal commands it has not been established to what extent additional irrigation would be required. Additional water released in this command is likely to create problems of water logging and salinity if extensive drainage facilities are not carefully planned and executed. No such details are, however, available.

The Central Water Commission representative informed the Committee that a report on the utilisation of Tehri water in the Command area is still under their consideration. Until such a plan has been finalised and assessed, it is not possible to assess the impact of the project on the command and, therefore, its benefits and even viability.

For all these reasons, the Committee feels convinced that the economic viability of the Project has to be re-examined, and that the cost benefit analysis, as presently done, is not adequate.

C. **CONCLUSION**: Taking into consideration the geological & seismic setting, the risks & hazards, ecological and social impacts accompanying the projects, the costs and benefits expected; and after a careful examination of the information and data available, the Committee has come to the unanimous conclusion that the Tehri Dam Project, as proposed, should not be taken up as it does not merit environmental clearance.

Appendix C

Memo presented to Prime Minister by Sunderlal Bahuguna on 7 may, 1992

Review of Tehri dam Project

Until now, the stress has been only on the technical issues- whether the Dam can withstand an earthquake of 8.5 magnitude on the Richter scale. It has been said that the design has been thoroughly revised and the dam will be safe. It is doubtful whether a Dam which was designed for an earthquake of 7:2 on the Richter scale (as was said by Mr. Docodov, the leader of the Russian geologists in his evidence before the Bhumla Committee) can withstand an earthquake of a higher magnitudes. The Russian structures are often mentioned to support this but it should be examined which are such structures in the USSR and what are the geological conditions of those hills. In this context. It should be seen as to how the revised design has been fitted into the base of the Dam which was fixed as early as 1978, when the work on the diversion tunnel started.

So far as the impact of the Uttarkashi earthquake is concerned, it should not be seen in the narrow sense as to what has happened at the Dam site, because the epicentre of the earthquake was near Maneri Dam which is more than 80 kms. from Tehri. The propaganda carried on by the Dam builders that there has been no damage to the Dam is ridiculous because no dam exists as yet. But the dam site is so fragile that there are wide cracks at least on the right bank slope between Top Terrace and the diversion tunnel head. These cracks were often filled but when during the 76 day Dharna the dam builders could not enter the site to hide this, the crevice has widened. These spots can be shown to anybody who would care to enquire into it.

Even if it is assumed that the structure of the dam is strong enough all surrounding hills which are fragile cannot be prevented from falling down into the reservoir. This had happened in the case of the Vijont dam in Italy in 1963.

Another aspect of this problem is the creation of several cracks which have developed in the earthquake hit zone of Bhagirathi catchment, especially above Pata and Sangrali villages near Uttarkashi, Saur and thandi Kamad villages of Jalkur valley and Maid-Marawaari, and Newalgaon villages, and Bhatgaon village of Balganga valley. These particular areas are known because these are near habitats but the area of Bhagirathi Catchment is more than 7000 Sq. kms. and a vast area is far away from habitats. There is a need to make a detailed on-the-spot study of the higher ridges where such cracks are apprehended. The past history of big landslides in this catchment right from Gomuckh glacier bears the evidence of huge landslide occurrences and devastation created by these landslides. There is no historical record of one such mishap which had blocked the river about 30 kms. downstream of Gangotri near

Jhala. Here Dhaini hillock fell down into the river bed and created a 10 km. lake from Jhala to Jagla where Bhagirathi flows very slowly and gives the evidence of the formation of the lake. this information is contained in a folk-song and was confirmed by the excavation of an old shiva temple in dharali village. The folk song mentions the existence of 240 temples in that area in the past. The landslides of Sera which blocked Jalkur in 1939, Loharinag in 1959 and Ddabrani in 1978 which blocked Bhagirathi occurred during this century. It is apprehended that when the recent cracks are filled with water during the monsoon there will be occurrence of landslides on a vast scale. This will shorten the life of the reservoir.

Economic Aspects: One of the arguments advanced in favour of the continuance of the Tehri dam project in spite of all the hazards is that an amount of rs. 650 crores has already been spent on this project. It is essential to examine this expenditure in the light of the CAG Report of 1986-87. A fresh and upto date special audit of the project by the CAG must be ordered in order to find out the propriety of expenditure incurred on different items. It is strange that during the first 10 years of project work, in which, besides construction, some rehabilitation was also done, a sum of rupees 300 crores was spent but, within the last three years, since the project was handed over to the **Tehri Hydro Development Corporation**, a larger amount than that was spent. Most expenditures were incurred in maintaining a large establishment at Delhi, renovation and airconditioning of the offices at Rishikesh, and benefits given to the high officers besides huge amounts spent on propaganda and publicity. This is one of the glaring examples of misuse of public money. There are many cases of corruption of which only two are being enquired by CBI where an amount of Rs. 3 crores in involved. corruption has been socialised by encouraging fake buildings to get compensation and giving many more times the compensation amounts to those who could grease the palms of the officers. Even after this extravagance, if the project is replaced with the run of the river scheme, most of the expenditure incurred so far can be utilised. The money that has been spent on the construction of Tehri town and the buildings roads and purchase of machinery is in tact. even the divergence tunnels may be utilised. The money paid as compensation is no loss because all the people except those who took excessive payments for their property by bribing the officers, are prepared to return the money. In fact, the present value of lands acquired in Athoor area for instance is 200 times more than the compensation paid to the farmers.

The economic aspects of the project should be examined from a different angle also. The local people who are losing the best flat land of Bhagirathi and Bhilangana valleys asked a question as to how they are going to be benefited by the Tehri Dam project which is being eulogised as the symbol of country's progress. Tehri Garhwal is the poorest district of India according to the first Inter-state and Inter-district Income Differential Report produced by the NCAER in 1956. In the hills there is one hectare of land for 17.6 persons and out of it the flat and irrigated land is very little. Area under irrigation in the district is only 12% of the

total cultivated area. The people enjoy free irrigation and fodder and fuel from the community forests. Though per capita holdings are very small, for one hectare of cultivated land, 11 hectares of forest and community land is available. We are pushing these innocent people who had been self-sufficient farmers for centuries, into the cruel hands of the market economy, where their very survival is at stake, The hill men and women enjoyed peace and security in their environment but now they feel themselves insecure, in the foothills, where 10% of the total oustees of the Tehri Dam project had already been settled 10 years ago. The Bhumla Committee which visited their settlement has given a pathetic description of their said plight.

The claims of the project authorities to supply irrigation water to the command area and drinking water to Delhi need to be re-examined in the light of the Report No. NA-4-755 9/3, dated 18.10.91 of the Soviet Ministry of Environment submitted to the Govt. of India. The Minister for water Resources did not respond to our queries about the contents of this report.

The Bhumla Committee has at length dealt with the adverse effects of the project on the proposed command area-at least 20,000 hectares farmers of the fertile soil which the Ganges brought and which will be trapped in the reservoir after the construction of the Dam; and throwing out of employment thousands of the small Patta peasants who depended for their survival on the flood plain land over which they cultivated vegetables after the receding of the floods. There will be no flushing of the Ganga between Narora and Allahabad where it resembles a dirty Nalla. All efforts made by Clean Ganga Project will be nullified if the monsoon water is not allowed to flow in the river.

This project will create regional imbalances as after the submergence of the valleys which are the hearts of the hills, and export of the water, there will be no chance for the hill villagers who had been, after independence, expecting that the water of the low-flowing rivers will be lifted to the tops and they will get an opportunity to regreen the naked slopes. This indeed is the only way to alleviate their poverty, check soil-erosion, manufacture new soil for the plains and stabilize the flow of the river.

Cultural aspects: The cultural aspect has been totally ignored so far. For the people of India, Bhagirathi has a special spiritual significance, as the river reminds them of the high ideals of penance, and self-less service with which the story of its origin is connected. Bhagirathi binds the whole country into one unit. Thousands of pilgrims which visit Uttarakhand and the holy shrines there, will be shocked to see the holy river impounded into a lake and the places of this inspiration disappear. All the places connected with the great vedantic saint Swami Ramatirth Padiyargaon Kutiya, Bamrogi cave, Malideval Kutiya and Simlasu Kothi will be under water. There can be no substitute for this loss because the future generations will be deprived of the inspiration which these places gave to many and which created great people like Sri Lalbahadur Shastri and Swami Raman Tirth, the two great servants of the people.

There are many more points which need to be considered because the affected people in the submergence area and even in the command area for which a disaster-management plan was to be prepared, were never given a chance to put forward their point of view. The first attempt they had made was through a petition submitted to Lok Sabha in 1977-78, but the Lok Sabha was dissolved before the completion of its term.

The reports of the Roy Committee and Bhumla Committee may serve as the basis for a review of the Tehri Dam Project. The evidence of scientists recorded by the Bhumla committee in this respect should be minutely examined. Independent opinion regarding seismic activity in future earthquakes, can only be of those seismologists of this country and other countries who have not in any way been connected with the formulation and clearance of the Tehri Dam Project either in the capacity of consultant or Chairman or member of any committee constituted for these purposes.

Now the composition of the Review Committee should be such that besides, the scientists and experts of different disciplines- seismologists, sociologists, economists, ecologists - spiritual leaders, and members of parliament should also be included. We hope that such a committee will reach unanimous decision and will protect this unique heritage of Humankind which is being ravaged for short-time economic gains, simply because of the concept of economic growth believes in the religion of economics and the ritual of technology.

Appendix D

Sunderlal Bahuguna's open letter to members of parliament
9 MAY, 1995

Dear Member of Parliament,

I send this appeal to you from Tehri miles away from Delhi, where we have been sitting on **Dharna** to stop the construction of ambitious Tehri dam Project. We began our peaceful movement on the auspicious day of **Vaisakhi** so that the **yagyna** being done to save the nation from the probable disaster and for the protection of right to life of the marginalised people may succeed.

We had made such efforts twice in December 89 and January 90 and from December 91 to April 1992. At first time we suspended our dharna thinking that the Government will take decision on this ill-conceived project after getting report of environment Minister's expert committee. but inspite of the unanimous adverse report of the committee, clearance was given to the construction neglecting this report. Second time after my 45 days prayerful fast through which we demanded the review of the project by a committee of the members of the parliament and other experts. Wee hoped that the review would be made and we would be given a hearing. But after earthquake of uttarkashi in 1991 and inspite of the warning of the scientists of an earthquake of higher magnitude in near future in the Himalaya, instead of converting this project into a safe run of the river project, the construction of coffer Dam has been started.

During last three years we approached the top government leader, leaders of different political parties, U.P. Chief Minister and Administrators but no solid decision was taken. Under these circumstances there was no other way left, but to sit on Dharna to attract the attention of the government.

The question can be raised that our action of stopping the construction of dam is anti-development. It might had been regarded as development project in sixties when there was an enthusiasm about Dam projects and when Tehri Dam project was conceived. But during last 35 years adverse social, economic, cultural and ecological impacts of high dams have been perceived. The era of demolition, not the construction of big dams, has began. The two dams on Loire river in France are being demolished because these were disrupting the free movement of the salmon fish. The problem of silt deposition, water logging and salinization and the inundating of fertile valleys, dense forests and the problem of uprooting of thousands of people have put a question mark on the utility of big dams. It centralizes the vital resource like water, which results in the degradation of water quality and creates regional imbalances.

Tehri dam is not affecting only one lakh local people but the poor people downstream who survive on vegetable cultivation in the flood plain of Ganga when flood water recedes in the Gangetic plain and who earn livelihood by catching fish will lose their jobs. The farmers of western U.P will be deprived of the fertile soil from the Himalaya. Recharge of ground water will cease. The sword of Democles remains hanging over the heads of the people living downstream in cities like Deoprayag, Rishikesh, Haridwar, Bijnor, Meerut and Buland shahar in case the dam bursts in the event of occurrence of an earthquake. Moreover, the siltation will shorten the life of the reservoir to 40 years. What will happen to irrigation and electricity generation after that? This dam is the temporary solution of a permanent problem.

As an alternative to this dam we suggested a run of the river scheme which would have been cheaper with a short gestation period. the fast flowing perennial rivers of the Himalaya have great potential for such projects. The advocacy of big dams. whose cost is escalating and even after spending 8.5 billion rupees is futile, power generation is a far off dream. This alternative was never considered . China achieved remarkable success by constructing 48204 small hydro projects with an installed capacity of 15055 M.W. This is a lesson for us to learn. Enumerable problems crop up when wee construct a dam in densely populated deforested and intensively cultivated country. The vital resource like water should be utilized where it falls Appropriate technologies for this should be evolved.

It is true that the perennial Himalayan rivers emerging from the glaciers should benefit the whole nation, but it is the extreme of callousness to deprive the people of Himalaya of this natural resource after uprooting them. There is a conflict between the national interest and the local expectations for the utilization of the natural resources of water, land and forest in the tribal and hill areas. The only solution to this problem is to use these resources in such a way that national interest and local expectations are harmonized. The maximum area of the river catchment should be under permanent tree cover. This is possible by tree farming for food, fodder and fiber. It will build permanent local economy along with the manufacture of soil and water for the nation. This will regulate the irregular flow of the rivers in which there is great difference between lean and peak season flow due to the denudation of the forests. These will be the permanent dams benefiting everybody. As a solution to the problem of Tehri dam specially the safety aspect and displacement which is the most horrible form of human torture. I had suggested to the Prime-Minister to constitute a review committee of members of Parliament, scientists and experts and spiritual leaders. I was encouraged to give this suggestion from the discussion which took place on 19th March 1992 during my long fast. This can be the only way to solve the difficult problems in a democracy. I have still with me the letters of some members of the Parliament in which they had made an appeal to give up fast for the service of the country. This encouraged me to remind you of this problem which is associated with our right to life. I beg your active participation in resolving this problem so that I may continue the experiments of **Ahinsa** (non-violence) in this area which

affects defence, source of **cultural inspiration**, economy and ecology of the nation.

On the second day of our **dharna** some labourers from the construction company came to me and told that they had come from far away Cuddappa district of Andhra Pradesh and they would starve to death due to the stoppage of work. After hearing their sad plight their problem is disturbing me, what has compelled them to come to thousands of miles away from their families and surroundings? Several people from the hills have also gone away in search of work. It has ended the family life. A disintegrated personality is developing in the children which is great danger to peace and security of the society. Big projects and big industries never provide adequate employment to the local people. In a agricultural country like India where population pressure has reached to the climax, this can be done through small Industries and equitable distribution of land. The father of the nation had given clear instruction in this connection and his disciple Vinbha Bhave had high lighted the problem of the landless. Having the experience of living as a common man, I can say this with confidence that they showed the right path inspite of the great pomp and show of big projects and all the attractions and mechanical farming. This is an opportunity to set a step on this path when we are celebrating 125th birth anniversary of Mahatma Gandhi and birth centenary of Vinoba Bhave.

I couldn't send personal letters to you because we are sitting here under a tarpaul in the scorching heat amid the dust and noise of vehicles running around. Besides this we are in a state of uncertainty. The dam builders are continuously creating pressure on the administration to put behind the bars a person, who is putting obstacle in the construction of a development project and hence an anti development. On the twenty sixth day we are not in the prison because the administration might be awaiting signals from the higher authorities. The contractors of this project are able to carry message from the top ruling authorities to the district level. taking decision on their own, which should be regarded as the proof of their administrative ability is not possible, as they fear to be the victims of the wrath of the higher authorities. This is eating up our democratic system from within.

I am not raising the question of corruption rampant in this project, because it is said that corruption is everywhere. You have discussed over several scandals in the Parliament. its only reaction is seen in the minds of the people that the roots of the corruption are in the top and it has become an etiquette. Upto what extent this etiquette perverted our society and administration, is a subject of great concern.

Humbly Yours,

Anti Tehri Dam Dharna Place
Tehri 249001 sd/ (Sunder Lal Bahuguna)

Appendix E

Excerpts from Sunderlal Bahuguna, article on 'plight of bhagirathi', Hindustan Times, New Delhi, 18 February, 1996

..........The worst crisis, which the Ganga had to face in the beginning of this century 1914-16, was due to the proposed diversion of the river into the Ganga Canal upstream to Haridwar at Bhimgoda. Madan Mohan Malviya organised a powerful movement against it an forced the British rulers to ensure the free flow of the Ganga at Harki-Pauri in Haridwar. But Malviya, fearful for the future of the Ganga, on his death-bed, called Justice Shiv Nath Katju and said, "Now is my last time, and I apprehend that after my death once again the free flow of the Ganga will be obstructed". Katju was stunned to hear Malviya, who said, "when a dam was constructed at Haridwar, India was a slave, at that time. How can it be possible in free India?" Malviya replied, "No , I am feeling that such efforts will be made after my passing away. I fear this and I have called you to promise that you will raise your voice against any plan obstruct the free flow of the Ganga."

Malviya's apprehensions have proved true - a 260.5 metre high tehri dam, the highest in Asia, is being constructed at tehri in Himalaya - the land of origin of the Ganga, Scientists and even the government committees have recommended the stoppage of construction of Tehri dam in this highly sensitive seismic zone. In the event of a dam burst, Rishikesh, Haridwar, Bijnor, Meerut, Hapur, Bulandshahr and all areas in between will be washed away. These areas will lack the fertile soil they get from the Himalayas. A people's movement against this disastrous project has been going on for the last 24 years. Despite this, the foundation of this dam, which has become a symbol of lies, deceit and corruption, has been laid. Instead of fulfilling the promises to review its technical, economic, social, cultural and ecological aspects, construction work has been speeded up. Truth is being assassinated with the help of two favourite weapons of the establishment - fear and greed.

The river to equally benefit all without any discrimination, is being destroyed by a dam built for a centralised system of water distribution, which benefits the rich and the industries. The dreams of the thirsty hill people to get water by pumping it up, have been shattered, because these schemes for the upstream villages of Bhagirath have been cancelled saying this will affect the quantum of water needed for Tehri dam.

Scientists have recently discussed a new danger to the Ganga after studying the Gangotri glacier. The glacier had receded by 731.5 metres in the last century. During this century, the rate of recession was 18 metres a year, which has gone up to 200 metres a year all of a sudden during the last four years. As such, the Ganga will meet the fate of Saraswati in 100 years. She will disappear. The cause of sudden rise in the rate of recession has been due to the seven dhabas at Gomukh to supply tea and parathas to the evergrowing number of tourists.

These dhabas burn 200 litres of kerosene oil a day.

The basic cause of this sad plight of the Ganga is our materialistic civilisation, which has made religion market the temples, technocrats and the experts 'dollar' the God. This new 'God' has trampled the values of culture. For the rulers, the Ganga-the revered river of the common masses-is a means to earn money. They are bent on extracting the last penny out of it.

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Human Population and Water: Meeting Basic Needs in the 21st Century

Submitted by

Peter H Gleick

HUMAN POPULATION AND WATER: MEETING BASIC NEEDS IN THE 21ST CENTURY

Peter H. Gleick[1]

Prepared for the Conference on Population, Natural Resources, and the Environment

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The Earth's limited fresh water is fundamental for all aspects of human and ecosystem survival and health. As human populations grow, economic, social, and military conflicts for water may well increase. In recent years, several analysts have expressed concern about growing water scarcity and contamination and the likely inability of many governments to meet the water requirements of rapidly growing populations (Falkenmark and Lindh 1974, Postel 1992, Gleick 1993, Engleman and LeRoy 1993). This paper explores the connections between human population and freshwater problems, and proposes a new way of addressing those connections. In particular, the concept of sustainable water use is defined and discussed in the context of growing human populations and a minimum water requirement for basic human needs is identified, quantified, and recommended. Evaluating access to this minimum water requirement may prove to be a more useful measure of human well-being than traditional water indices.

THE PROBLEM

Although the Earth is often called the "water planet" because of the vast amount of water present, these resources are unevenly distributed in space, time, and type (see, for example, Shiklomanov 1993). Ninety-seven percent of all water is salt water -- too salty to drink or grow crops. And the vast majority of the other three percent is locked away from human reach in the vast icecaps of Greenland and Antarctica and in deep groundwater aquifers. The small amount of fresh water technically and economically accessible to humans is unevenly distributed in space and time; so unevenly that society spends billions of dollars every year to move water from wet areas to drier areas, to store it in wet seasons for coming dry periods, or to clean otherwise undrinkable sources.

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These geophysical characteristics lead to a wide range of water-related problems, including interstate conflicts over access and quality, competition between urban, rural, and environmental uses, severe human health problems, and constraints on economic development.

Many basic human needs for water remain unsatisfied. In 1990, nearly 2 billion people lacked access to clean drinking water and adequate sanitation according to the official UN definitions. Over a billion people throughout the world are served either by sewage treatment systems that do not measure up to the standards set by ancient Rome, or by no systems at all. The direct and indirect human costs of this are enormous and include extensive health problems, high labor costs -- particularly for women forced to travel long distances each day to [illegible] water to meet even the most minimal needs -- and severe limits on the extent and form of economic development. As a result of the lack of clean water and sanitation services, there are billions of cases of water-related diseases with over five million deaths every year (Warner 1995). Table 1 shows current estimates of water-related disease morbidity and mortality. Many of these health problems are getting worse. In 1991, a new cholera pandemic spread across Latin America, which had been free of cholera for more than one hundred years and which now has more cholera cases than any other continent (see Figure 1).

COMBINING POPULATION AND WATER ISSUES

Hydrologists typically measure water scarcity by looking at per-capita water availability or use; i.e., the water available or used in a region per person (Falkenmark and Lindh 1974, Engleman and LeRoy 1993). The average amount of water available per person in 1850 was about 43,000 cubic meters per year. By 1990, this figure had dropped to 9,000 cubic meters per year, simply because of the increase in global population. When evaluated on a more detailed regional level, the distribution problems described above become even more apparent.

Figure 2 shows the great variations in current per-capita water availability for each continent. Oceania has over 70,000 cubic meters per person per year (m^3/person/year), the average for all of Africa is under 7,000 m^3/person/year, while that of Asia is only 3,400 m^3/person/year. Even greater disparities are noticeable if one looks at a national or regional basis. For example, Iceland, Norway, Canada, and New Zealand all get more than 100,000 cubic meters of water per person per year; some countries in Northern Africa and the Middle East have less than 100 m^3/person/year (Gleick 1993). Populations of the eastern United States get two or three times the amount of water per

capita that California gets, and many times the amount received by the arid southwestern U.S.

Just as physical water availability is unevenly distributed around the world, per-capita water use also varies widely for physical, economic, and social reasons. North Americans use over 1,600 cubic meters per person per year, while the average in Europe is 725 m^3/person/year (Figure 3). In Africa the average water withdrawal is under 250 m^3/person/year, reflecting the limited physical resources available, the large populations, and poorly developed water-supply systems.

When the total amount of water available is relatively fixed, larger and larger numbers of people will reduce total per-capita water availability over time. This simple observation has spawned a substantial literature, ranging from the early work of Falkenmark and Lindh (1974) in which regional water availability is compared to water demands under different population scenarios, to the more recent study of Engleman and LeRoy (1993, 1995 revision), which takes national water availability data from Gleick (1993) and combines them with UN population projections to the year 2050 to highlight those regions where scarcity either already exists or is likely to develop in the coming decades.

Table 2 from Engleman and LeRoy (1995) shows the 1990 population living in regions with water "scarcity" and water "stress," usually defined as regions with less than 1,000 and 1,667 cubic meters per person per year respectively. Using United Nations low, medium, and high population projections, this Table also shows how those populations will increase up to the year 2050. If population growth is closer to the high population track than the low projection, 250 million more people will be subject to severe water scarcity in the year 2025. By 2050, the difference would be nearly 1.4 billion people.

There are some important limitations to these kinds of assessments. First of all, they are based on net water availability data for large areas, which have some significant holes: they usually do not include water for rainfed agriculture, they are often based on computed data, not measured data (see Gleick 1993), they often include water either committed to riparian countries lower on a river or already used by a riparian neighbor upstream, and they hide important smaller regional differences.[2] For example, India, China, and the United States, among other countries, have regions that are already extremely water-short. Yet average data for these countries do not reveal immediate problems (Engleman and LeRoy 1993).

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2 Engleman and LeRoy are aware of, and discuss many of these limitations in their report, but approaches for dealing with many of them have not yet been adequately developed.

Because of these limitations, the long-term goal of water planners must be to ›ve beyond simple per-capita evaluations and to rethink the population and vironment debate by helping to place population processes and water problems in their cial, political, and economic settings. Below, some principles of sustainable water use ꜱ presented that may prove more useful for evaluating regional problems and for fering solutions. In addition, a new measure of absolute scarcity is presented: the ›pulation lacking access to a minimum water requirement for basic human needs.

ꝚINCIPLES OF SUSTAINABLE WATER USE IN THE 21ST CENTURY

'ater is essential to sustain life, support ecosystems, and provide for economic :velopment, community well-being, and cultural values. How are these varied benefits, hich sometimes conflict, to be prioritized? What is to be sustained? For how long? 'ho are the beneficiaries? In the context of fresh water resources, any discussion of ıstainable development requires that we understand both the physical resource and the :nefits or services that those resources must provide.

As described above, fresh water is widely and unevenly distributed around the orld. The water available for use in any place or by any group of users is not constant, ıt varies widely over time and space due to both natural fluctuations in the global ⁄drologic cycle and the non-natural fluctuations caused by human interventions. In the ›sence of any human interventions, natural ecosystems have evolved and adapted ıemselves to these natural hydrological fluctuations. The imposition of human systems ften alters both the natural hydrologic regime and the ecosystems that depend upon ıem.

Using the per-capita measure described above, any increase in population will :ad to a decrease in per-capita water availability, which has usually been assumed to be ad. A better definition of sustainable water use is the maintenance of a desired flow of pecified *benefits* to a particular group, undiminished over time.[3] Refining this further equires that the sustainability of some set of benefits be maintained without affecting the bility to provide comparable benefits into the future to all groups -- similar to the more ;eneral definition developed during the work of the World Commission on Environment ınd Development and widely quoted (WCED 1987).

The desired set of benefits provided by water is unlikely to be the same across lifferent users or periods of time. Indeed, such benefits vary widely given political,

' Note that there is a difference between water use and the benefits of water use. There are several ›ays in which declining water use can occur without a decline in the benefits of water use, such as through mproved efficiency of use. This distinction is often ignored by water analysts.

religious, cultural, and technological differences. Using the definitions above, water use is unsustainable if the services provided by water resources and desired by society diminish over time. Equity requirements would also require that a reduction of services over time to one user group be declared "unsustainable" even if other users are able to maintain their desired services.

There are two ways in which unsustainable water use can develop: through alterations in the stocks and flows of water that change its availability in space or time; and through alterations in the demand for the benefits provided by a resource, because of changing standards of living, technology, population levels, or societal mores.

The first factor -- water availability -- is affected by both natural and anthropogenic factors, including climatic variability and change, population growth that reduces per-capita water availability, contamination that reduces "usable" water supplies, physical overuse of a stock, such as groundwater overdraft, and technological factors. Similarly, the second factor -- water demand -- is not constant, increasing with growing populations, changing as social values and preferences change, and increasing or decreasing with technological innovation and change.

Sustainable water use also involves the institutions that control the distribution of water in space and time. Social systems to manage water resources must be capable of coping with changes in supply and demand, and in responding to varying priorities of water use under different conditions. Given all of these issues, a working definition of "sustainable water use" was developed by Gleick et al. (1995):

> *the use of water that supports the ability of human society to endure and flourish into the indefinite future without undermining the integrity of the hydrological cycle or the ecological systems that depend on it.*

This definition of sustainable water use provides an overarching framework by which decisions about human water use can be judged. By itself, however, it is too general to offer guidance for water managers, planners, and scientists. In order to make decisions about how to allocate and use water resources, other goals and criteria need to be identified. Explicit criteria and goals for the sustainability of freshwater resources are presented here in Table 3. These criteria lay out human and environmental priorities for water use, taking into account not only the needs of the current populations, but also those of future generations.

These criteria and goals are the result of considerable dialogue and analysis with academic, governmental, and non-governmental interests working on regional, national,

and international water problems. They are not, by themselves, recommendations for actions; rather they are endpoints for policy -- they lay out specific societal goals that could, or should, be attained. In particular, these criteria can provide the basis for alternative "visions" for future water management and can offer some guidance for legislative and non-governmental actions in the future (Gleick et al. 1995).

WATER AND POPULATION: A NEW APPROACH

The first criterion in Table 3 deserves special mention in the context of growing populations. As stated, all humans should be guaranteed access to sufficient water to maintain human health, independent of the size of the population. The concept of meeting basic human needs has been put forth in several different international environment and development fora, including the 1977 Mar del Plata conference -- one of the earliest international efforts to address global water problems.

> ". . . all peoples, whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs" (United Nations 1977).

This concept was strongly reaffirmed during the 1992 Earth Summit in Rio de Janeiro and expanded to include ecological water needs:

> "In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems" (United Nations 1992).

Gleick (1996) defines and quantifies "minimum water requirements" (MWRs) for four basic human needs: the supply of fresh water quantitatively *and qualitatively* sufficient to provide minimum drinking water for survival, water for sanitation services, and modest household needs for cooking and cleaning. The recommended MWR is shown in Table 4. Gleick (1996) recommends that international organizations and national and regional governments adopt a minimum standard of 50 liters per person per day (l/p/d) of clean water and guarantee access to it independently of economic, social, or political status. Unless this basic need is met, large-scale human misery and suffering will continue and grow in the future.

Using this measure, it is possible to evaluate the size of the population lacking access to the basic requirements for even a minimally satisfactory quality of life. Vast

regions of the world and hundreds of millions of people lack the water required to meet the basic human needs proposed above. Table 5 lists those countries of the world whose average domestic per capita water withdrawals, as reported to the United Nations and other organizations, fail to provide a minimum water requirement of 50 liters per day. According to 1990 data, fifty-five countries and nearly a billion people fell below the minimum recommended in this paper. There are actually eight countries whose total reported water use in *all* sectors falls below the recommended MWR for just basic human needs. While in some cases this may reflect problems in reporting actual water use, it also reflects the dire resource conditions in wide regions of Africa, Asia, and Central America. Furthermore, population growth is increasing in most of these regions faster than improvements to water supply.

In contrast to these figures, domestic water use in all industrialized countries far exceeds the MWR, though the quality of this water varies widely. In the countries of western Europe, the recommended MWR is typically less than 25 percent of total domestic use. In the U.S. and Canada, a MWR of 50 l/p/d is less than 10 percent of total domestic use, reflecting the much greater availability and use of water in homes.

There are strong reasons to believe that the number of people failing to receive the recommended MWR is actually far above the numbers reported here. The data in Table 5 are country averages, and several large countries, such as India and China, report that their average domestic water use only marginally exceeds 50 liters per person per day. We know, however, that average national water-use data hide significant regional variations, with large segments of populations usually falling below the average, while wealthier portions of the population tend to use far more per capita. An additional problem is that there are few data to indicate the typical *quality* of the water received. Domestic water quality is a severe and widespread problem, and it is likely that many people who may receive more than the recommended quantity are getting contaminated and unhealthy water.

The Role of Different Policies in Reducing Water Stress

Two problems deserve special attention: increasing populations that lead to both decreasing per-capita water availability and increasing overall demand, and changing conditions (particularly technology and climate) that affect both water supply and demand. In the first case, assuming constant levels of total water availability, increasing populations lead directly to decreasing per-capita water availability and pressures on the levels of benefits or the mix of benefits that water provides. Ultimately, unlimited population growth must lead to decreasing water availability, the reallocations of water

from one user or sector to another, the unsustainable "mining" of non-renewable stocks of water, and, in the end, decreasing overall human well-being.

In the second case, technological developments can alter water availability and affect levels of water required to satisfy demands. In theory, practically unlimited quantities of fresh water are available by mining water currently trapped in glaciers and icecaps, or on an even larger scale, through the mass desalination of seawater. In practice, however, increases in overall water supply will occur only where the value of water exceeds the economic and environmental costs of supplying that water through new technology.

The other basic assumption -- that overall water supply is fixed -- is now being challenged by the problem of global climatic change. As evidence accumulates that climatic changes are a serious concern, hydrologists and water managers must rethink old assumptions about the reliability of supply. While total water availability has always been stochastic, existing systems are designed and built to accommodate that known variability. But some of the largest changes expected from the greenhouse effect will be associated with the hydrologic cycle and water availability (Schneider et al. 1990, IPCC 1992, IPCC 1995).

The Fallacy of Addressing Population in Isolation

Some analysts address water problems, or indeed any resource problem, by addressing population alone. Their argument, to put it in its most simple form, is that fewer people will place less pressure on scarce and finite resources. This argument is certainly true, as far as it goes, but it doesn't go far enough. Population growth rarely, if ever, acts alone to produce water scarcity and looking at it in isolation shifts attention from policies that may be equally or more effective at reducing human misery. By ignoring the related roles of consumption levels, the form of resource use, and the role of economics, technology, and culture, such an approach often misses many of the most important and effective policies for solving problems. Population, human welfare, water availability, and use must be considered to be dimensions of the same complex problem.

But how effective would other factors be in altering water needs? Society is constantly making conscious and unconscious decisions that affect demand and supply of water. Some of the factors worth looking at include improvements in the efficiency of water-using technologies, new technology for water use, changes in lifestyles and personal preferences, different agricultural policies, and so on. Below, I explore the effectiveness of a few of these alternatives.

Improvements in Water-Use Efficiency. Studies are only now beginning to be done on the potential for extensive water efficiency improvements. The least work has been done in developing countries and in the agricultural and domestic sectors -- paralleling the problems in quantifying potential energy efficiency improvements in the 1970s and 1980s.

A good example is Egypt, which is entirely dependent on the Nile River for its water, ninety-seven percent of which originates outside of Egypt's border. Egypt is already at the limits of its water supply. Because of Egypt's limited options for new supply, efforts are being made to improve the efficiency of their agricultural and urban sectors. Egypt also is faced with a high and rapidly growing population. This combination is already causing water stresses throughout the country. Figure 4 shows how total water demands would rise under the medium and low United Nations population projections through the year 2025, if the per-capita water use remained constant. As this figure shows, the difference between the two population scenarios is quite small, suggesting that even extensive population policies would not be of much use in solving Egypt's water problem.[4]

In reality, of course, Egypt is unlikely to reach even this level of water use because of absolute constraints on availability. In the absence of inexpensive desalination, their only alternative is therefore to see declining per-capita use of water. This can happen in two startlingly different ways: with *declining benefits* resulting from continued inefficient use of water in traditional ways; or with *constant or improving benefits* resulting from improving water-use efficiency and changing water policies.

With no change in water allocations, the efficiency of water use, or water management, growing populations will lead to a straightforward decline in per-capita use of water and a comparable decrease in agricultural output, industrial productivity, and human well-being. If, however, efforts are made to reallocate water from inefficient users or to improve the efficiency of current uses, it is possible to maintain or even increase productivity and well-being with a constant absolute amount of water. Figure 5 shows how total water demands would be affected by annual improvements in water-use efficiency of only one percent per year, a number considered by many to be both plausible and achievable (Abu-Zeid and Seckler 1992), particularly if agricultural policies are permitted to change. In this case, using the medium UN population projections, total per-capita water demands drop more than 20 percent. In a country like Egypt, where per-

[4] This is, in no way, an argument against implementing extensive population policies -- there remain many other substantial benefits in implementing such policies. Rather it suggests that the rationale for such policies must come from their impact on other critical social, economic, and environmental problems.

capita water use is relatively high because of large irrigation withdrawals, substantial changes in water use are possible without threatening basic human needs.

CONCLUSIONS

If we cannot solve the population problem, we ultimately face declining per-capita water availability and use, and eventually, declining quality of life and benefits. As a result, policies to reduce rapid population growth in water-short regions are necessary and urgently needed. But such policies cannot and should not be the only approaches taken to address water problems. Indeed, in the short run, they may not prove to be the most effective, equitable, or just.

In the near-term, policies to reduce population growth (short of intensely repressive policies or some severe health crisis) will not be sufficient to prevent serious water-related problems from getting worse, particularly human health problems, ecological disasters, and interstate conflicts. In addition, reducing the population growth rate, even to zero, is no guarantee that sustainable and equitable water use will result. This is a classic case of something that is necessary but not sufficient. Even in a zero-population-growth situation, society can still have social inequities, contamination of water supplies, intentional manipulation of water, political conflict, and loss of aquatic ecosystems, unless these problems are directly and quickly addressed.

A new way of thinking about long-term sustainable use of water is to focus on meeting basic human and environmental needs for water. The definition of sustainable water use presented here, together with the proposal to satisfy a minimum water requirement for all humans should help water planners set explicit goals for water supply. Ultimately, decisions about defining and applying this concept of a minimum water requirement will be based on political and social factors, but the concept may prove useful in meeting basic water needs for the next century.

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Table 1: Estimates of Morbidity and Mortality of Water-Related Diseases

Disease	Morbidity (episodes/year)	Mortality (deaths/year)
Diarrhoeal Diseases	1,000,000,000	3,300,000
Intestinal Helminths	1,500,000,000 (people infected)	100,000
Schistosomiasis	200,000,000 (people infected)	200,000
Dracunculiasis	100,000 (people infected, excluding the Sudan)	-
Trachoma	150,000,000 (active cases)	-
Malaria	400,000,000	1,500,000
Dengue Fever	1,750,000	20,000
Poliomyelitis	114,000	-
Trypanosomiasis	275,000	130,000
Bancroftian Filariasis	72,800,000 (people infected)	-
Onchocerciasis	17,700,000 (people infected; 270,000 blind)	40,000 (mortality caused by blindness)

Source: WHO 1995

Table 2: Populations in Water-Scarce, Water-Stressed, and Water-Abundant Regions (millions)

	1990	2000	2025	2050
Low UN Projection				
Scarcity	132	277	653	1,059
Stress	206	270	2,008	2,446
Abundance	4,935	5,521	4,922	4,390
Medium UN Projection				
Scarcity	132	281	945	1,928
Stress	206	273	2,379	2,458
Abundance	4,935	5,589	5,057	5,420
High UN Projection				
Scarcity	132	285	904	2,429
Stress	206	277	2,591	5,270
Abundance	4,935	5,657	5,460	4,179

Data from Engleman and LeRoy 1995.

Scarcity: less than 1000 cubic meters per person per year availability.
Stress: less than 1667 cubic meters per person per year availability
Abundance: more than 1667 cubic meters per person per year availability

Table 3: Sustainability Criteria for Water

1. A minimum water requirement will be guaranteed to all humans to maintain human health.
2. Sufficient water will be guaranteed to restore and maintain the health of ecosystems. Specific amounts will vary depending on climatic and other conditions. Setting these amounts will require flexible and dynamic management.
3. Water quality will be maintained to meet certain minimum standards. These standards will vary depending on location and how the water is to be used.
4. Human actions will not impair the long-term renewability of freshwater stocks and flows.
5. Data on water resources availability, use, and quality will be collected and made accessible to all parties.
6. Institutional mechanisms will be set up to prevent and resolve conflicts over water.
7. Water planning and decision-making will be democratic, ensuring representation of all affected parties and fostering direct participation of affected interests.

(From Gleick et al. 1995.)

Table 4: Recommended Minimum Water Requirements for Basic Human Needs

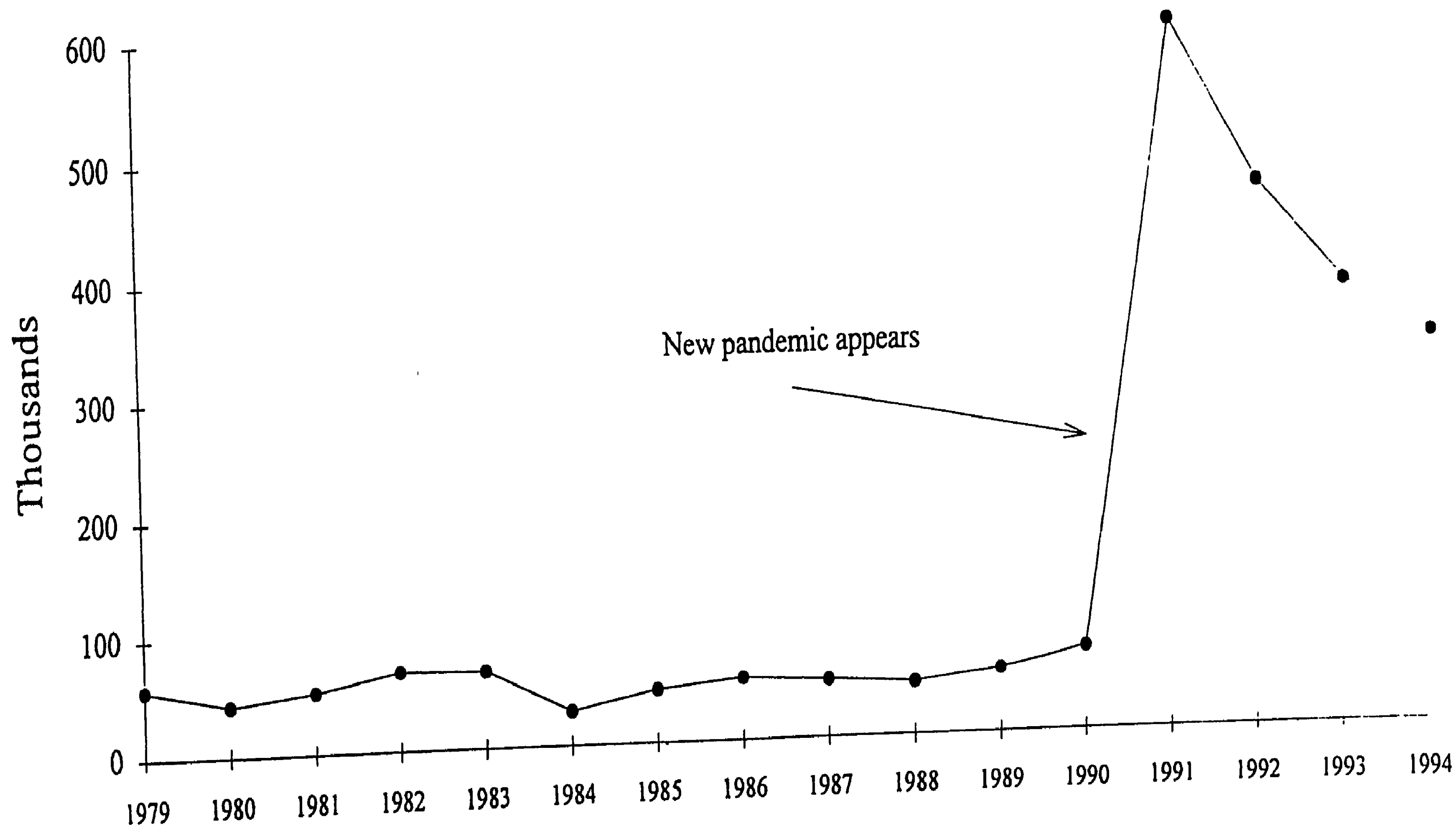
Purpose	Recommended Minimum [a] (liters per person per day)
Drinking Water [b]	5
Sanitation Services [c]	20
Bathing	15
Cooking and Kitchen	10
Total Recommended Minimum Water Requirement	**50**

(a) Excluding water required to grow food (see Gleick 1996). These minimum quantities must also be of a minimum quality sufficient to prevent water-related diseases.
(b) This is a true minimum to sustain life in moderate climatic conditions and with average activity levels.
(c) An average (not minimum) of 40 l/p/d is considered adequate for direct sanitation hookups in industrialized countries. In extremely water-short regions, sanitation systems that use no water are available, but rarely embraced socially.

Table 5
Countries with Total Domestic Water Use Below 50 l/p/d

Country	1990 Population (million people)	Average Domestic Water Use in liters/ person/day	Domestic Water Use as a Percent of the MWR of 50 liters per person per day	Country	1990 Population (million people)	Average Domestic Water Use in liters/ person/day	Domestic Water Use as a Percent of the MWR of 50 liters per person per day
Gambia	0.86	4.5	9	Burkina Faso	9.00	22.2	44
Mali	9.21	8.0	16	Senegal	7.33	25.4	51
Somalia	7.50	8.9	18	Oman	1.50	26.7	53
Mozambique	15.66	9.3	19	Sri Lanka	17.22	27.6	55
Uganda	18.79	9.3	19	Niger	7.73	28.4	57
Cambodia	8.25	9.5	19	Nigeria	108.54	28.4	57
Tanzania	27.32	10.1	20	Guinea-Bissau	0.96	28.5	57
Central African Republic	3.04	13.2	26	Vietnam	66.69	28.8	58
Ethiopia	49.24	13.3	27	Malawi	8.75	29.7	59
Rwanda	7.24	13.6	27	Congo	2.27	29.9	60
Chad	5.68	13.9	28	Jamaica	2.46	30.1	60
Bhutan	1.52	14.8	30	Haiti	6.51	30.2	60
Albania	3.25	15.5	31	Indonesia	184.28	34.2	68
Zaire	35.57	16.7	33	Guatemala	9.20	34.3	69
Nepal	19.14	17.0	34	Guinea	5.76	35.2	70
Lesotho	1.77	17.0	34	Cote D'Ivoire	12.00	35.6	71
Sierra Leone	4.15	17.1	34	Swaziland	0.79	36.4	73
Bangladesh	115.59	17.3	35	Madagascar	12.00	37.2	74
Burundi	5.47	18.0	36	Liberia	2.58	37.3	75
Angola	10.02	18.3	37	Afghanistan	16.56	39.3	79
Djibouti	0.41	18.7	37	Uruguay	3.09	39.6	79
Ghana	15.03	19.1	38	Cameroon	11.83	42.6	85
Benin	4.63	19.5	39	Togo	3.53	43.5	87
Solomon Islands	0.32	19.7	39	Paraguay	4.28	45.6	91
Myanmar	41.68	19.8	40	Kenya	24.03	46.0	92
Papua New Guinea	3.87	19.9	40	El Salvador	5.25	46.2	92
Cape Verde	0.37	20.0	40	Zimbabwe	9.71	48.2	96
Fiji	0.76	20.3	41				

Figure 1: Cholera Cases Worldwide



Data from World Health Organization 1995b

Figure 2: Per-Capita Water Availability, by Continent

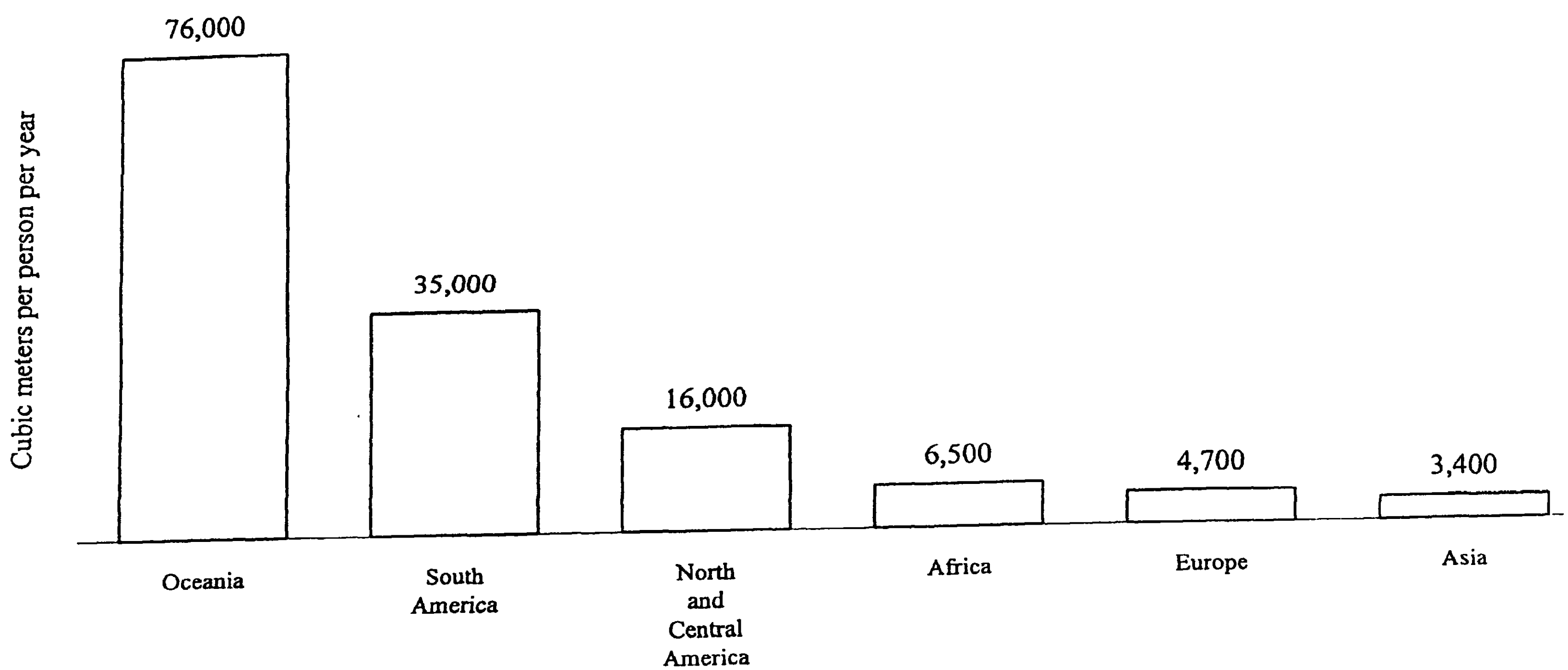
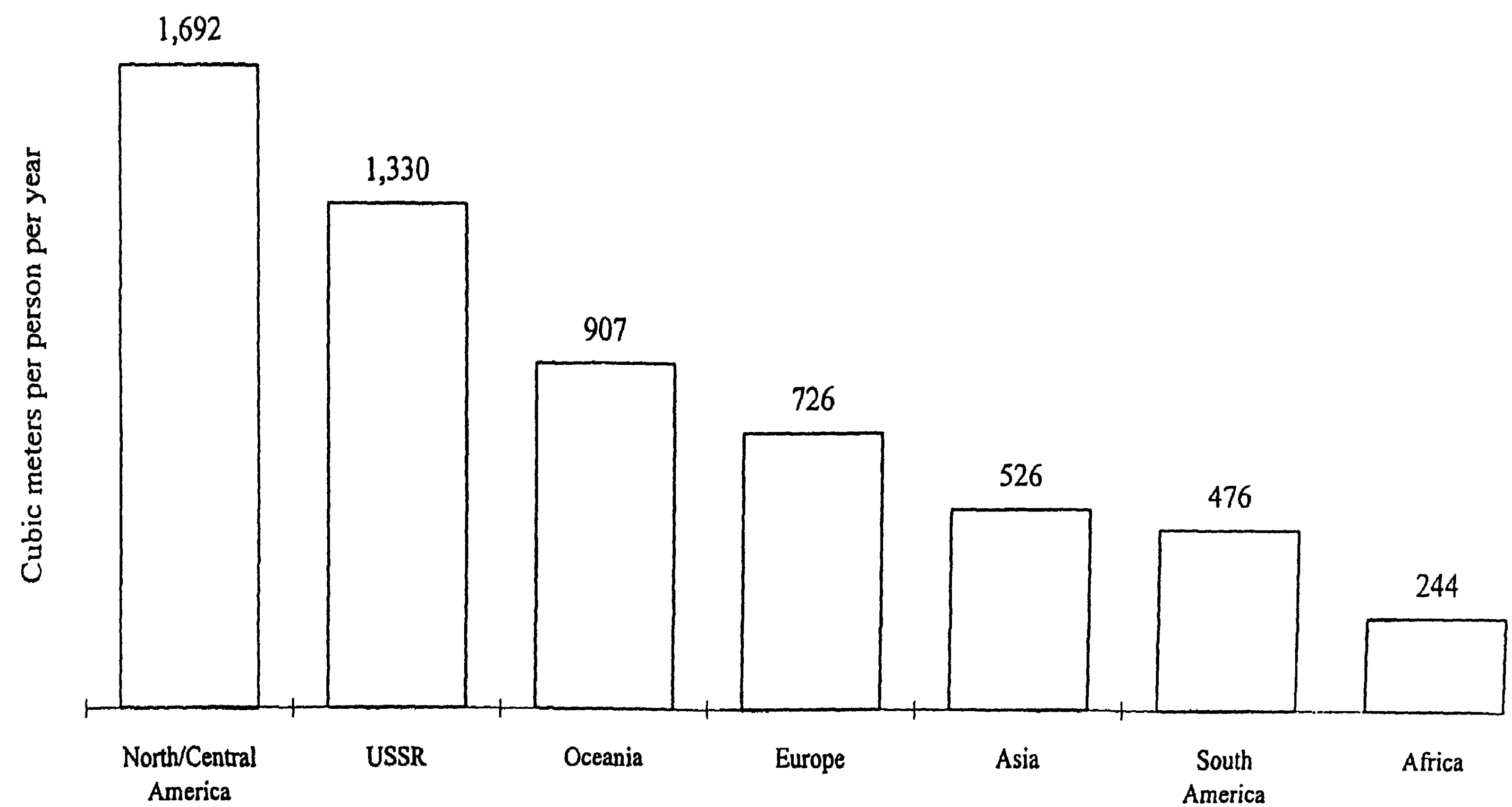


Figure 3: Per-Capita Water Withdrawal, by Continent



Data from Gleick 1993.

Figure 4: Water Use in Egypt: Low and Medium Population Projections

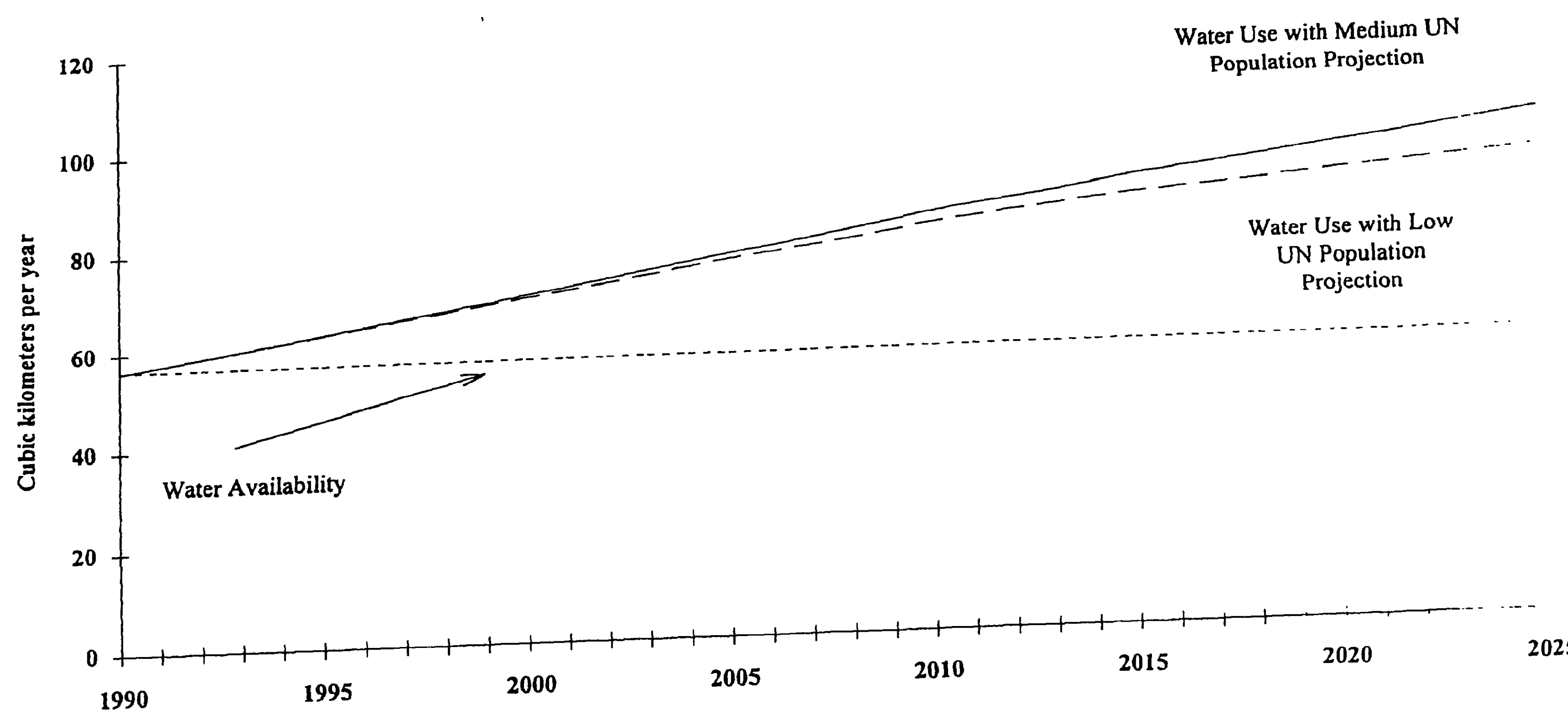
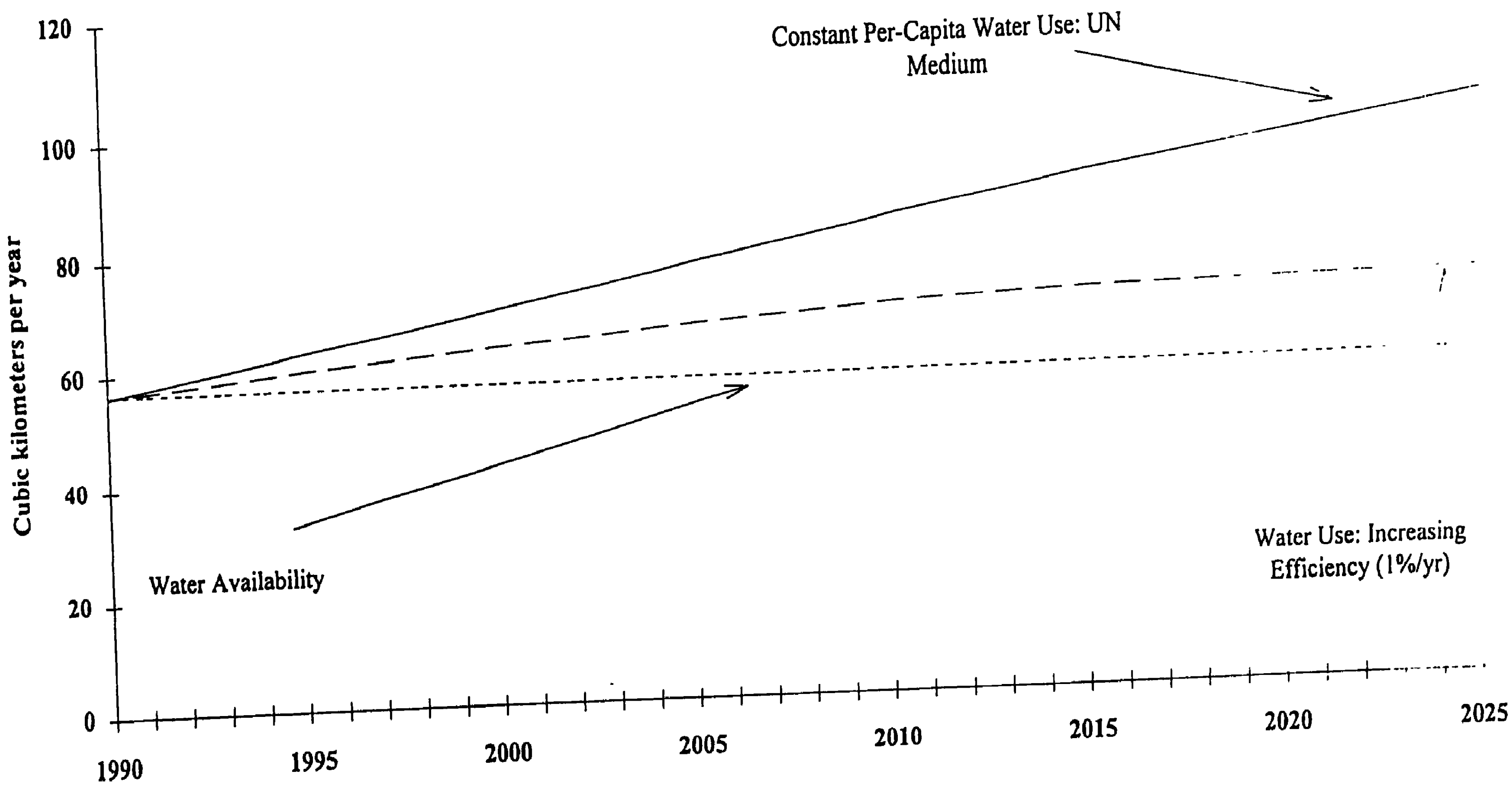


Figure 5: Water Use in Egypt: Changes in Water-Use Efficiency



The Long, Dark Shadow: Population and Water in the Middle East

Submitted by
Thomas Naff

THE LONG, DARK SHADOW:

POPULATION AND WATER IN THE MIDDLE EAST

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The Long, Dark Shadow: Population and Water in the Middle East

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A few years ago, Paul Demeny of the Population Council in New York declared that the world's hydrological conditions "are dwarfed by demographic changes."[1] Whatever the accuracy of that statement, it does have the virtue of focusing one's mind on the conjoined issues of water and population. For all societies, the volume, quality, and adequacy of water supplies are governed by climate, ecology, and the environment in combination with population size, distribution, and economic activity. Everywhere, the way in which these factors intermingle determines the quality of life. The interactive consequences of over-population and water have become virtually universal, no more so in any part of the globe than in the Middle East which is, in many ways, a microcosm of the worst aspects of the world's population explosion.

The Middle East has, historically, been of great geo-political importance to the West and, today, with its huge oil reserves, constitutes a vital strategic and economic interest for the industrialized world. Therefore, any event or development that menaces the stability of the region is of intrinsic concern—as demonstrated by the rapidity with which an alliance was formed to oppose Iraq's invasion of Kuwait. The potential threat posed by the rapid upward spiral of population expansion in the Middle East where water is both scarce and maldistributed, has created a situation of multi-faceted complications very difficult to resolve and frought with potential disaster.

Understanding the nature of the region's demographic problems is prerequisite to devising strategies for avoiding or managing hydro-demographic calamities. Because the phenomenon of rapid population growth is world-wide and its consequences interconnected across regions, placing the Middle East's hydro-demographic problems in a global context provides an essential perspective.

The Global Context of Hydro-Demogtraphic Issues

It is widely agreed among demographic experts that the decade of the 1990s may well be decisive in settling the future of this planet as a habitation for humankind.[2] Decisions will be made that will determine whether there will be only two rather than three times more people before population growth ceases, and whether the rate of damage to the earth's environment, which is the inexorable consequence of the existence of living creatures, will be faster or slower. What is certain is that in the next half century the largest and most rapid demographic increases, ninety percent, will occur in the world's poorest countries (some of which are in the Middle East), those least able to provide for the newly created generations or invest in their future. The world's population is

growing by about 95 million people a year. By 1998 there will be about 6 billion people, 8 billion by 2020, and, if current growth trends continue, before the middle of the next century, the number will increase to 10 billion. One fifth of the earth's 5.5 billion inhabitants receive 82.7 percent of the world's total income; the poorest one-fifth get 1.4 percent.[3]

As humans multiply, they are literally consuming the earth at an alarming rate. Indeed, a waxing human population and the increasing per capita consumption of resources by humankind now constitute the primary source of pressure on natural resources.[4] This incessant growth has already inflicted many harmful, often permanent changes on the environment, particularly the depletion and degradation of land and water resources, as well as massive deforestation. One serious consequence has been an actual decline by 1.9 percent a year of available arable land per capita throughout the decade of the 1980s, a trend that has carried over into the '90s.

Because water, cropland, and population are inseparable, the negative effects of such losses on long-term fresh water supplies are obvious and real. Currently, total global cropland is estimated to be about 1.5 billion hectares. The most optomistic projections of arable land assume an approximate possible total of between 3.2 and 3.4 billion hectares. However, just about all of the best soil is already tilled. The remainder, which makes up the bulk of the latter forecast, is already "either less fertile, insufficiently rainfed or easily irrigated, infested with pests, or harder to clear and work."[5]

This combination of circumstances—declining water supplies and cropland together with rising, unsustainable rates of population growth—is striking in certain parts of the world, such as the Middle East, China, Southasia, and parts of Africa, that are known to be ecologically vulnerable and to suffer resource inequities. A country is said to suffer land scarcity when 70 percent or more of its potential cropland is cultivated. Presently, without a substantial increase in arable land, the per capita average of cropland worldwide will drop from 0.28 to 0.17 by 2025 should the current rate of population growth continue.

Nearly 73 percent of all rural households in developing countries are landless and nearly a billion rural dwellers (exclusive of China) have too little land to provide subsistance levels of food and fuel. Were China taken into account, the numbers would increase by 100–200 million people. The world loses to erosion between 2 to 3 million hectares of cropland a year, with twice that amount lost to urbanization and another million or so to excess salinity due to water scarcity, poor management of land and water, and misuse of chemical fertilizers. Moreover, one-fifth of the earth's cropland is in some stage of desertification. At these rates of loss, the world's arable land will decrease by 100 million hectares by the year 2000.

Because the factors that deplete croplands are interactive, their effects tend to ramify. A simple example is what can occur when even a single basic factor such as water is reduced or shifted away from croplands: there is a

decrease in cropped acreage, changes in cropping patterns and practices must be made, degredation of soil (and perhaps the beginning of a process of desertification) ensues, or farming ceases altogether. In agriculture, these impacts may further unfold in a variety of other areas, e.g., water quality and quantity, land quality, community well-being, social institutions, and commodity flows at local, national, and international levels.[6]

In the same way that a key ecological change in the pattern of soil usage can trigger developments that impact widely, so too does the factor of human induced change function in regard to renewable resources that are vital to the existence of humanity. Most renewable resources are inseparable parts of very complex, dynamic natural systems in which the effects of over-exploitation of one basic unit can suffuse the entire system. Thomas Homer-Dixon of Toronto University offers us a convincing example:

> Forests, for example [he writes], not only provide wood for fuel, construction, and paper. They also reduce the variance in the hydrological cycle by slowing the runoff of rainwater and by absorbing and releasing some of it through transpiration; they stablize soils and reduce erosion; they absorb and fix atmospheric carbon dioxide that otherwise might contribute to global warming; and they provide a habitate for diverse organisms. In turn, each of these renewable services helps sustain other goods and services in the ecological system. Thus the loss of forests can generate much more than just scarcity of wood: it can also generate scarcities of soils, of rainfall, of sustained and manageable river flow for hydropower and transportation, and of resevoir and irrigation capacity (since these systems become plugged with silt). If forest loss is widespread enough, it can diminish the biodiversity we need for our medicines and industries, and it might boost climate change. Some of these problems will induce yet other shortages: for instance, the silt that washes into the sea can smother coral reefs and thereby damage local fisheries.[7]

The total number of people defined as poor by the United Nations now constitute about one quarter of the world's population. Population growth has vastly outpaced the resources needed for governments in developing or poorer nations to provide basic services to their citizenry. For example, urban households without safe water rose from 138 million in 1970 to 215 million by the end of the 80s, and in the same period, households lacking adequate sanitation leapt from 98 million to 340 million.

Another consequence of the expanding gap between the planet's swelling population and such finite vital natural resources as water and soil has been the creation of what has been labeled "ecological marginalization." Burgeoning

numbers of poor people able to do so are migrating from wasted, dried up lands to fertile ground or to the margins of cities where they seek new forms of livelihood, thereby feuling the surge of urban sprawl in all parts of the world. This movement of populations binds ever more tightly environmental and resource degredation with intractable poverty, especially in regions with brittle environmental conditions, with the result that "The world's poorest people are thus increasingly clustered in two types of areas: remote and ecologically fragile rural areas, and the edges of growing urban areas."[8]

Empirical and historical evidence indicates that across the globe in societies where populations are high and per capita incomes are low, those societies lack the capacity to respond effectively to the consequences of that combination of circumstances by reorganizing existing institutions or creating new coping mechanisms—particularly if at the same time there is a scarcity of such vital natural resources as water. These same societies tend to be deeply traditional; for them, change is difficult and slow, and, short of harsh coersive measures, they would find it very hard to stem—let alone reverse—the tide of population growth long enough to root a new institutional order.

In the past, humankind has been stunningly inventive in finding solutions to the spectrum of its problems. But because of the sheer scale of multilayered, interactive demographic and environmental problems that is the hallmark of the twentieth century, a scale and complexity that sets it off from any previous epoch, it can no longer be comfortably assumed that the alleviating fruits of human ingenuity will be available quickly enough, with enough equity and uniformity to all societies in time to stave off widespread disaster. Biotechnical advances reach the poorest, most needy nations last. These are societies where virtually all the necessary skills, not to mention wealth, are very thin or absent, and where problems are so deep, population growth so rapid, that little progress toward a solution is made even with the help of technology.

Because biotechnology requires very high and complex levels of science, the lead-times to proven results and widespread application are perforce much longer than poor nations, already crisis ridden with the bulk of the world's population, can bear. Moreover, given the magnitude, difficulty, unpredictability, and multifarious nature of population-driven problems, it is certain that a whole series—perhaps many series—of significant biotechnical exploits will be required before widespread easement comes.[9] Although the world as a whole may not be facing a ruinous fate in the immediate future, for many individual nations—many in the Middle East—the race between population growth, resource scarcity, and social and technical ingenuity will grow more desparate and failure will appear more imminent. An unbounded faith that humanity will somehow produce answers to all of nature's uncountable processes would seem to be unwarranted. Whatever the level of wealth or poverty, technology or competence, in any given place and circumstance, the larger the population the greater effects on the environment and resources.

Population and resource issues involve not only a scale of mass but a scale ime as well. Over time, even a relatively short span of time, the increase in olute numbers of people could overwhelm present biotechnical solutions or der useless those in planning or experimental stages. It is a demographic om that at the current yearly average growth rate of some 2 percent, the world h its finite resources and diminishing fresh water supplies and quality pland will double its population about every generation. One of the plications of such rapid growth is that there is no longer a sufficient margin of ie for societies, particularly the more destitute, to adapt to the new absolute mbers before the cumulative negative effects of the increase make their pact. Furthermore, ecological processes such as desertification or long-term natic swings and trends in precipitation, which tend to be interlinked with ny other environmental mechanisms in complicated ways, operate on a time rizon so long as to be beyond the vision of the land users (who are frequently victims of environmental changes) or their governments. In this context, it is rth noting that governments notoriously "tend to intervene late, inadequately ineffectively."[10]

In these circumstances, even if the rate of change were to hold more or less ady, it is the absolute numbers rather than proportions, ratios, or percentiles it matter most. Any of the aforementioned data attest to this fact. Even a iall percentile alteration of either growth or decline can result in an order of ange amounting to hundreds of millions in absolute numbers. For example, tility in India and Pakistan had fallen from 6 children per woman to 5.3 tween 1975–80; but the rate of fall decreased between 1980–85 to only 5.1—an parent insignificance in percentiles and time. But in absolute numbers, if there ere to be no change, it means that by 2005 India will have acquired another 216 illion people (roughly equivalent to the present population of the U.S.) and kistan's population will have risen by 57 million (just about equal to Egypt's rrent population).[11] An increase from, say, 1 billion to 2 billion at any given ne represents an increase by a factor of only one; but suppose the rise is from 5 llion to 10 billion, then the absolute increment is five times more.

Obviously, if the world's population remains on its present trajectory, the iplacable number of new bellies that will have to be filled with food and water a relatively short time will be immense. As the earth's inhabitants multipy at hat are arguably unsustainable rates while universally demanding higher ving standards, the need for world-wide intensification and expansion of griculture will be greater than ever. Satisfaction of this need will require a zeable increase of irrigation which is indispensable in arid, semi-arid and emperate zones (which include the Middle East); this in turn will require gnificant accretions of fresh water globally, and more rapid development in the elds of hydro and bio-technology. When large-scale calamity does afflict the iost populated, vulnerable nations, the combination of massive numbers and ick of resources means that technology alone can rarely effect a rescue, not only

because of the depth and difficulty of the problems, but because many other complex, interlaced policy and decision making issues are involved: political, ideological, cultural, religious, attitudinal, economic, psychological, social, strategic, and sometimes epidemiological.

The process of development in many nations has ineluctably opened local agricultural production to macro-economic forces of the global market. When this circumstance is joined by population pressures for more production without commensurate increases in capacity, resources, or technology, the traditional equilibrium among population, established institutional systems, and resource bases is often irreparably disrupted and unreplaced by a new balance, frustrating the achievement of developmental goals (in the Middle East, Sudan and Egypt illustrate the point). This is attested, in part, by a marked fall in the proportion of the labor force in agriculture. Rural to urban migration has for decades depleted the agricultural labor force, while the remaining landless workers and farmers migrate seasonly. The result in some parts of the world is that the rural labor force is becoming increasingly female and elderly. [12]

Population Stress and Conflict

The causes of conflict and war are complex and dynamic—involving such factors as an imbalance among demographic, economic, environmental, ecological, and political variables, as well as cultural values and attitudes toward aggression. The demographic and resource constituents of conflict are tightly coupled and often inspire perceived needs for access to more resources and markets, somtimes leading to increased aggressiveness. The bond between a population and its resource base, principally water in arid regions such as the Middle East, is one of the basic elements that tie demography with international politics. Aggressive behaviour and even full-scale wars have often been the concommitants of population stresses.

Historically, a correlation can be drawn between conflict and population over-growth, particularly where demographic strains are put on the available resources, on their utilization, and on the socio-economic and cultural relationships between people and their environment, and where migration is not an acceptable option. In the nineteenth and twentieth centuries the growth of national populations, the quest for resources, and per capita income emerged as important components in the expansionist ambitions of nations, in the nationalist ideological underpinnings of those longings, and, in part, as factors in military ependitures and alliances. As examples, one can cite the nineteenth century colonial expansion of Europe (concurrent with the rivalry for strategic resources

among the leading colonial powers) and the rise of the European Axis powers and Japan, in the 1930s and 1940s.[13]

However, population growth is not invariably related directly to conflict or always accompanied by ecological tensions. Other options, such as diplomacy, negotiations, and trade can be resorted to when seeking resources, and emigration or migration (when feasible) can be a means for relieving population pressures. Emigration is a long-term, limited choice whose effects are normally felt only over decades or generationally. In the course of this century, as nations have increasingly restricted or closed down immigration, emigration has ceased to be a viable means for relieving demographic tensions.

As a facet of demographically based conflict, environmental and resource-induced large-scale population migrations must be reassessed. The implication of recent studies appears to indicate that there is no clear, convincing link between environmental degradation, large population migrations, and conflict; it is possible that a connection exists, but what linkage can be discerned is remote and indirect. It is clear, especially in the poorer regions of the world, that the combination of environmental degradation, resource scarcity, and migration seems to plunge the migrating group into a swirl of poverty and deprivation. While the precise causes of large-scale mitgrations may not be altogether clear, it is apparent that they are rarely the outcome of a single factor such as environmental or resource depletion, though the environmental factor may sometimes have a magnifying effect on the causes of migration. Exceptions to this observation are severe, prolonged drought or civil war, but in most cases the migrations engendered by these causes are not necessarily permanent; there is usually a return flow of migrants when the situation has improved.

It is also difficult to separate purely environmental from economically inspired migrations, except in extreme situations like flood and drought which produce environmental refugees. The usual causal pattern is a conflation of several related factors with one or two of them being dominant, such as water degradation and scarcity, deforestation, desertification, civil war, terror, etc. Evidence indicates that this has been the case in the Middle East when, over the last two centuries, relatively infrequent large-scale migrations have occured. Conflict is not the normal consequence of migrations, and environmentally produced migrations are more likely to result in social dislocations and prolonged distress rather than conflict. Migrating populations are almost always destitute, weak, extremely dependent, vulnerable, and lack the wherewithal for starting a conflict or touching off violence. Sometimes migrants are driven to violence by terrible conditions, but generally they tend not to resort to strife unless sufficiently empowered, and when they do, the scale of violence is usually containable by governments.[14]

Water and Population in the Middle East—Context

The effects of the world's ascending population size, already manifest, have thus far been tolerable, but a continued, relatively moderate and acceptable pace of demographically related alteration of the earth's evnironment and ecosystems is by no means guaranteed, especially in nations or regions that suffer impoverishment. U.N. experts have concluded that "At some point in the not too distant future, the changes may cross a threshold into catastophe."[15]

In the meantime, as population pressures build and resources dwindle in various parts of the planet, barring at the very least stablization if not declension in growth patterns, the prospect is for rising human impoverishment accompanied by suffering, social dislocation, instability, truncated lives, and conflict. Admittedly, these afflictions do not necessarily stem exculsively from demographic causes; rather, they often involve an amalgamation such factors as climate, political corruption, power struggles and factionalism, ideological extremism, and economic mismanagement—as is the case in several parts of the Middle East. When these conditions combine with a rate of population growth that is unsustainable in relation to climatic conditions and water resources, the process of disintegration and the consequences are greatly intensified, often making solutions exponentially more difficult to achieve. Somalia in the last decade is a virtually perfect model of this proposition.

In the Middle East that aforementioned threshold of catastrophe is discernible on the short horizon. The region-wide population growth rate is about 3.2 % per year. If that average rate were maintained, the region's population would double in about 30 years—this, in an area where endemically poor soil quality necessitates unaffordable amounts of scarce water for irrigation and huge amounts of chemical fertilizers which contribute significantly to the degradation of water quality. The prognosis for countries like Jordan, Egypt, and Syria, and for the Palestinians of the Occupied Territories is especially ominous. Their populations are multiplying at annual rates that range from 3.3% to 3.6%, a growth pattern which is unsustainable in relation to their water supplies. Complicating this picture is an intensification of religiously inspired political opposition to government efforts aimed at curbing population increases.

The Middle East's hydrological problems are abundant. They range from scarcity and maldistribution through mismanagement, pollution, and poverty. Only climate, the ultimate cause of scarcity, surpasses population as the greatest factor of stress on the region's water stocks. In the Middle East, climate mediates the hydrographic relationship between water and population. Judging by the consistently high rate of growth in this century, it would seem that the Middle East's population rise is almost as difficult for policy makers to control as its climate.

The single, overriding, immutable cause of the Middle East's water scarcity is the way the earth, in relation to the sun, functions as a stupendous heat pump, generating a constant process of intense evaporation within a broad zone that includes the region (this phenomenon is known as Hadley's Cell). The

implications of this situation are multifaceted: the region's fresh water stocks will probably never increase, the margin of safety for sustainable supplies will always be very fragile in most of the area, and on the present trajectory of population growth the region is probably only two or three gernerations away from disaster—that may be avoidable if the curve is deflected downward in time.

Balance and accuracy in our consideration of the reciprocal relationship between population and water in the Middle East, requires a few comments on certain characteristics of scarcity. Severe water scarcity or water chronic shortages, when accompanied by such other factors as maladministration, too many people, factionalism, or socio-economic inequities, can lower the state's capacity to respond effectively to people's needs which results in state weakness and in turn produces social disorders which raise tensions and the potential for conflict (Somalia and Ethiopia again come to mind).

But it must be noted that scarcity is rarely absolute and the principal problems accompanying scarcity are normally those of reduced institutional capacity, management, allocation, and prices as demands change.[16] Population pressures exacerbate these difficulties and make their solution more complex. In this context, resource use trends become all the more significant for analysts, planners, and policy makers.

Consumptive use trends relative to population growth forecasts are portentous in crucial parts of the Middle East. For example, in the Jordan basin total water use for all purposes presently varies between 2700 and 2900 million cubic meters (mcm) per year among Israel, Jordan, and the Occupied Territories (a little more than 100% of safe-yield stocks). The total population for the three groups is (rounded off) about 13 million. This aggregated population is projected to rise between 2040 and 2050 to 36 million and total water use to 7000 mcm (domestic use 3620 mcm, industrial 480 mcm, and irrigation 2900 mcm).[17]

What these data show, even if they are only within percentages of accuracy, is the magnitude of effort that will be required by all the actors in a little more than a generation to avert a catastrophic situation. It is an axiom of Middle Eastern affairs that all major events in one part of the region will ultimately have an impact on events in all other areas. Were a prolonged, large-scale demographically related water scarcity crisis to overtake the peoples of the Jordan basin, its destablizing effects would quickly ramify throughout the Middle East.

Water and Population in the Middle East—Interactions

The Middle East lies within the dry areas zone of West Asia and North Africa (WANA) and exemplifies on a lesser scale the climatic and arability profile of the WANA region as a whole.[18] The dry areas of WANA consist of 978 million hectares (ha) within the winter rainfall zone, but only 13 percent of the land is arable, and of that 13 percent, 35 million hectares are under irrigation

while 93 million ha are rainfed; the range of the latter varies significantly from year to year. Seventy five percent of the region is desert, some of it at high altitude; the remainder is either naturally flooded or is waste-land. The climate is generally characterized by winter rainfall and hot dry summers. Rainfall is variable, averaging between a stingy 100–600 mm/yr, the highest precipitation falling on coastal areas, with a sharp fall-off as one moves inland away from the coast. Rainfall throughout the WANA region is not only insubstantial, it is erratic within and between years, causing enormous fluctuations in crop production. The length of a crop growing season as determined by moisture and temperature varies between about 70–100 days at high elevations and areas with rainfall of less than 300 mm/yr, to 140–210 days in areas with more than 400 mm/yr. In the WANA zone, irrigated agriculture is much more important in relation to local economies and production than dryland farming. Finally, the average population growth rate for entire WANA region is about 3% per year with little sign of abatement.

One of the major consequences of these conditions is that within the WANA region food imports typically constitute over 20 percent of total imports and represent about five percent of GDP (Gross Domestic Product). In fact, the Middle East, is among the largest food deficit regions in the world. Food imports for the whole WANA bloc account for more than 40 percent of all food imports by the entire developing world.

The Middle East is one of those world areas where there is significant rural to urban migration of the labor force, thus intensifying this trend. There is no country in the region that is an exception. Coupled with slow growth in domestic product has been the rapid rise in food demand owing to lower real prices, higher incomes, population growth, and large flows of food aid from North America and Europe. Such large scale food assistance has lowered the real cost of imported food, while at the same time basic food prices have been heavily subsidized in virtually all Middle East countries, thereby encouraging domestic demand and sometimes depressing incentives for local producers.

An integral part of those food subsidies has been heavily subsidized water, for example: almost 100% in Iraq and Syria, 66% in Israel and Jordan, about 75% in Egypt. In several of these countries, the subsidies are off budget; that is, they are not listed as part of the official national expenditures. Overvalued exchange rates and protection for industrial sectors lead to more dependence on foreign imports.

The unadorned fact about water and population in the Middle East is that the limited productivity of the Lower Nile Valley, the Fertile Crescent, and the narrow Mediterranean coastal plain (encompassing the Jordan basin) with their deficient, erratic seasonal rainfalls and frequent droughts simply will not continue to support the fast growing population of the region—a population that has doubled since World War II and is expected to double again in the next 30 years—if present conditions prevail or worsen. The average growth rate of about

2 percent per annum for the Middle East region as a whole, unless significantly :duced within the next 30 years (which appears highly unlikely), will produce)metime between 2015-2020 a conservatively estimated population of 454 iillion people (when the four North African states are inclcuded, the number ses to 560 million, and in 2020, the projected figures are 495 million excluding 'orth Africa and 607 million total when the latter is added).[19]

It cannot be reckoned with surety whether in the second half of the next :ntury a regional population of between 500 and 600 million can be sustained by ıe area's total water and other economic resources if current patterns of)nsumption and waste persist. What is certain is that with such a projected opulation, and given the hydro-geology and climate of the region, the water ıpply and demand ratio will be placed under enormous strain and the more rid and poorer nations of the Middle East will be living constantly on the ointed end of a hydrological crisis.

Current trends in the Jordan basin offer an almost perfect medium-term lustration of that proposition. Consider the implications when the rigid climatic mitations on water supply are added to the burgeoning population of the ›rdan basin: Jordan's population and those of the West Bank and Gaza are ıcreasing at an annual rate of about 3.5% annually—at this rate the doubling me is only about 25 years. The situation in Gaza is especially troubling. In 992, reports indicated that the growth rate in Gaza reached an incredible 5.8%. n February 1996 the head of the Palestinian Bureau of Statistics stated that 'alestinian women in Gaza have an average of 7.44 children and he estimated hat Gaza's present population of 934,000, would double in 15 years, adding that 'Gaza will explode. There will be no job opportunities, insufficient services, a evere housing crisis, and all kinds of other problems." Palestinian officials have :xhibited reluctance to undertake a rigorous program of birth control because Gaza is the stronghold of Hamas, the radical Islamic party which opposes such :fforts as being anti-Islamic.[20] The Israelis are increasing at an annual rate of ıbout 1.9% but anticipate an absolute increment of some one million emigrés rom the former Soviet Union by the end of the decade.

Using medium, non-linear projections, and allowing for a projected eveling off by the year 2000 to an annual average of about 3.2-3.3 %, and ıccounting for the relative youth of the population (about 50% is under 25 years of age), by around 2015-2020 Jordan's population will have increased from present numbers by 178 percent, from 2.7 million to 7 million, Israel's from 4.6 million to 8 million (including the Russian emigres), and the Palestinians in the West Bank and Gaza will jump from 1.75 million to 4.7 million. At these rates, sometime between 2015–2020 the Jordan basin's population—excluding Syria—will reach about 19 million people. The basin's known water resources will support a population of about 14 million.[21] The resultant questions are manifest—where is the water for the surplus population to come from, and will it be possible to provide it in time to avoid a potentially devastating crisis? Given

the complexity of the hydropolitical, economic, and demographic issues involved, in those circumstances 25 or 30 years constitutes a relatively short lead-time to mitigate the situation.

Projections and assumptions about the relationship between a scarce vital natural resource and a population that is growing at an apparently unsustainable rate always carry an element of uncertainty when conditions are as dynamic as they are in the Jordan basin. It may be rationally assumed that where water is concerned responsible authorities will not wait until a crisis is full blown to take steps to mitigate or avoid the problem—although the record of the political leadership in the region is by no means perfect in this regard as evinced by the fact that the Jordan basin is already on the cusp of a serious crisis. Nevertheless, let us further assume that a felicitous combination of actions will be taken within the next twenty five or thirty years that will ensure the availability of a sufficient supply of water for the projected population—although some hardships may be experienced along the way. That is a genuinely possible—even probable—scenario, though for it to come to pass in any degree, there must first be achieved a sustainable peace agreement between Israel and the Arabs; a peace of such nature as to engender sufficient trust to enable the inter-riparian cooperation essential for an equitable solution to the basin's water problems. (Should the current peace-seeking effort be derailed or take an inordinate time, it is just conceivable that a major basin-wide water shortage crisis could have the salutory effect of forcing cooperation among the otherwise hostile riparians depending on the prevailing political configuration in each country).

But, even with such a peace, it remains dauntingly difficult to avoid the potential crisis posed by the projected population growth rates. Following are some of the critical actions that must be taken in just the right mix, more or less uniformly, and at the right time among all the basin's riparians. To achieve optimal effect, the planning and management of these actions must be coordinated basin-wide:

1) There must be a persistent, effective, effort to reduce the population growth rate to sustainable levels

2) Effective, standardized systems of gathering and processing information and data must developed, and the information must be shared freely

3) Substantial reductions must be made in irrigated agriculture

4) There must be a significant increase in water recycling and the use of only recycled water for irrigation (progress is being made on this point)

5) Significant improvement of on-farm efficiencies and the employment of efficient irrigation methods such a drip irrigation must be introduced (drip irrigation is ubiquitous in Israel and spreading rapidly in Jordan)

6) There must be significant improvements in water infrastructure including pipelines, irrigation canals, pumping stations, local (metered) delivery systems, etc.

7) There must be a significant increase in water transport capacity and improvement in distribution efficiency

8) Large-scale, shared desalination projects must be developed for the entire basin an there must be an assured, affordable supply of energy

9) Significant improvement must be made in management and organization

10) There must be a move away from supply-side management policies to demand-side management; this means planning and management must stress risk minimization over maximum utilization[22]

11) There must be a reduction of water subsidies and realistic pricing policies

12) Significant investments must be made in bio-technical research, conservation technology, and new sources of energy, and in the adoption of new technologies

13) Inter-basin transfers from such nations as Turkey (together with required pipelines and/or port facilities and pumping stations) must be negotiated

14) Conservation together with public awareness must be practiced rigorously in all sectors

15) The national economic restructuring necessary to accomplish most of these improvements must be undertaken

16) The regional and international financial communities must make available and disburse the necessary (substantial) funds in fair proportion among the basin's riparians in a timely fashion

17) There must be effective contingency planning for the probability of prolonged moderate to severe droughts to which the basin is subject

18) Catchment and storage capacity (including groundwater recharge) must be increased

19) There must emerge among the leadership of the various basin governments the sustained vision, will, and courage to face the political risks involved

20) There must be sustained political stability among the basin's actors

It is only if the first and last two—always uncertain, always very difficult—items obtain that all of these inter-related, complex actions can be undertaken with hope of success over the next twenty five or thirty years. If all of the key requisites are satisfied, it might be possible for the Jordan basin's water supply to bear the weight of a population of some 17 million or so people. But unless the population growth rate is stablized and the trend reversed significantly in the same period, that hard-won success will have been be short-lived. The demographics if the situation hold the key to avoiding a major water-driven crisis in the time permitted by current circumstances. Even allowing for the water supply increases if the necessary reforms are undertaken successfully, a continued population rise would soon create a new demand on fixed water stocks already fully utilized and therefore far less capable responding adequately.

While the Jordan basin offers us a prime illustration of the hydro-demographic problems of the region, its situation is not unique. Along the Euphrates and Tigris basins the populations of Turkey, Syria, Iran, Iraq, and the nations of the Arabian Peninsula have an average growth of about 3.5% per annum, which means that their numbers will double in the next quarter century (the populations of Turkey and Iran are projected, respectively, to rise to 96 million and 124 million by 2020). The populations of Egypt, Sudan, and Ethiopia, the Nile River's lower riparians will also experience a doubling of their inhabitants (Egypt's population alone is expected to be around 98 million).

Along the Euphrates and Tigris basins, the double-barreled problem of water and population is less one of supply as it is maldistribution, whose pernicious effects are the same as scarcity. The water sources of the Fertile Crescent can, hypothetically, support a much larger population than at present, but most of that water is controlled by Turkey, the upper riparian on both river basins—96 percent of the Euphrates and about 64 percent of the Tigris. Turkey is in the midst of a vast hydro-agricultural project in southeast Anatolia known as the Greater Anatolian Development Project (GAP) which will eventually consume the greater supply of both rivers. Should Turkey succeed in fully

implementing GAP over the next 25 years (more realistically the next 40 years), and in the absence of an enduring allocation agreement with the two lower riparians, it has been reliably calculated that Syria would receive about 40 percent less flow of Euphrates water and Iraq's share could be reduced by as much as 70 percent.[23] Even if there is an agreement, little doubt exists that Syria and Iraq would still lose flow.

In these circumstances, Syria affords us a model delineation of the systemic connections—and their complexities—of water and population in the Middle East and of the way that the hydro-politcal dimensions of water and population quickly branch out. Should the GAP scenario play out over the next 25 or so years, its impact would spill over from the Eupharates into the Jordan basin because Syria is a riparian of both the Euphrates and Jordan rivers, linking them politically and systemically.

All of the ramifications for Syria that proceed from a combination of reduced flow from the Euphrates and a population that will have reached 35 million might not be calculable at this juncture, but some consequences are foreseeable, beginning with those on the Yarmouk River whose sources rise in Syria and propel the river across the border into Jordan (the total annual average flow of the Yarmouk is only about 425 million cubic meters per year). The situation creatd by GAP would almost certainly drive Damascus to use significantly more, if not all, of the sources of the Yarmouk reducing the supply to Jordan with serious after-effects on the latter's economic development plans in which the Yarmouk figures prominently, at time when the Kingdom's own population will have more than doubled.

Israel, too, is concerned about happens to the flow of the Yarmouk, because Israel has withdrawn yearly an average of 60-70 million cubic meters of water from that river (and has taken as much as 100 mcm) to use for replenishing via Lake Kinneret its over-used coastal plain aquifer, further reducing the availability of Yarmouk water for Jordan. With Israel's own population projected to reach 8 million in 30 years, the importance of this source will increase accordingly, particularly as any final agreement with the Palestinians will require less Israeli water withdrawals from the West Bank. The Palestinians, whose population is expected almost to quadruple by 2025, understandably insist on taking back most of the Occupied Territories' water supplies.

Presently, in the negotiations between Syria and Israel, water is a critical factor. Syria's insistence on the full recovery of the Golan Heights is motivated not only by strategic and political considerations, but by the fact that the Mount Herman Springs in the Golan are one of the (lesser) sources of the Jordan River. Whoever controls the Heights not only gains the Golan's water supply (which is not critically significant in mass) but becomes an upper riparian on the Jordan, having the power to control part of the river's flow.[24]

At the same time, in the light of GAP, among other considerations, Syria is and will be all the more concerned with the maintenance of its influence in

Lebanon because the other major river on which it depends, the Orontes, rises in that country. This is another important negotiating salient between Damascus and Tel Aviv that is affected by what happens along the Euphrates. Bear in mind, in this context, that in all of the links of this putative chain of events, population pressure is an influential moving force.

Another complicating and unpredictable variable that must be taken into account in any scenario that is concocted is the impact of militant Islamic revivalist movements that are ubiquitous in the region. While as yet these movements tend to be localized, and no leadership or ideology has emerged under whose banner they can unify across national boundaries, they do already share one demographic notion: they oppose official attempts at birth control as anti-Islamic, western-inspired conspiracies. Should this perception persist and be reinforced by the rise of militant Islamic parties—there is no reason to assume that they will not—the problem of unsustainable population increases in the region will only grow more serious and difficult to manage.

Of the thirty nations in the world that reached population stability by 1995, none are in the Middle East or North Africa. Nine countries in the Middle East (including Jordan and Israel) currently overdraw their renewable ground and surface water supplies. The availability of water per capita will, on average, be 2.35 times less by 2025 if current patterns of population growth and consumption persist. This is indicative of widespread chronic water scarcity. Throughout the Middle East, with very few notable exceptions such as Turkey, the demand for food has surpassed the the carrying capacity of the region's croplands.[25] The highly populated nations of the Middle East—some of which face impoverishment—have been, as indicated, obliged for some time to import large quantities of food. Egypt is a prime example: There is a net increase of about one million Egyptians every ten months, forcing Egypt to become a significant importer of grains, meats, fruits and vegetables paid for with dwindling hard currency reserves, earned in some measure, paradoxically, by the export of agricultural products. It has often been pointed out that when a nation exports agriculture it exports water—this is referred to as "embedded water." Given the region's ecological profile—its dry climate, poor soil quality, water scarcity, and unabated population growth—few nations in the Middle East can afford to ship off much of their water in this fashion. Agricultural exports account, on average, for only between 3%-5% of GNP Gross National Product) across the region. Light industry contributes to GDP 30 times per unit of water as does irrigated agriculture.

If ways are not soon found for controlling population growth, and for practicing more rational, coordinated, basin-wide water management, the region's water consumers face a certain future of increasingly severe water deficits. It must be stressed that the effects of constant water shortages tend to become magnified because they are cumulative: the deficit becomes progressively larger; aquifers are damaged; water quality is degraded; wells dry

up or become useless; crop patterns must be changed; costs rise; and eventually, public health, particularly for the poor, is adversely affected. There is also danger that some of the damage will be irreversible. All of these injurious effects would be very much exacerbated by drought, the occurrence of which, given the region's climatic history, must be taken as inevitable. The hydro-demographically based problems of the region are so serious, and there is so little lead-time to solve them, that the region's political leaders, whatever their ideological stripes, may be induced by the sheer, overriding necessity of survival, to take cooperative, mitigating actions despite the unavoidable risks and pain. But the question is, can they, will they act in time?

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[1] Conference on Environmental Change and Acute Conflict, Toronto and Ottowa, June 1991.

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The 'Second India' Revisited
Population Growth, Poverty, and Environment Over Two Decades

Submitted by
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THE 'SECOND INDIA' REVISITED: POPULATION GROWTH, POVERTY, AND ENVIRONMENT OVER TWO DECADES

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THE 'SECOND INDIA' REVISITED:

POPULATION GROWTH, POVERTY, AND ENVIRONMENT OVER TWO DECADES

In September 1994, the International Conference on Population and Development debated the consequences of an almost inevitable doubling of world population for human wellbeing and the environment. New perspectives on gender inequality and reproductive health have come to the fore, but the main issues are still those that were argued at the second World Population Conference in Mexico City in 1984 and at the first World Population Conference in Bucharest in 1974.

Almost twenty-five years ago, well before the Bucharest Conference, the Ford Foundation in India tried to promote a dispassionate examination of issues that were no less contentious then. It assembled a group of Indian scholars to assess the implications of the doubling of India's population that demographers in 1970 considered inevitable. Then as now, India was considered by many to be one of the critical grounds on which the dynamics of population, poverty, and resource scarcity would be played out. Radically different diagnoses and prognoses were being offered. A notable expatriate agricultural expert, impressed with the success of high yielding rice and wheat varieties, proclaimed "Something fundamental and dynamic, with far reaching consequences, has been introduced into the Indian agricultural scene since 1965... The quantum change in technology has been added to a foodgrain production which was already growing at a rate of 2.5 percent annually since Independence. Therefore, it is difficult to imagine a growth rate of foodgrain production over the next decade of less than 3.5 percent annual trend ... We feel that a 5 percent rate is most probable" (Cummings 1969).

However, equally confident observers predicted disaster -- India's inability to feed its growing population: according to Paul Ehrlich's, The Population Bomb: "It now seems inevitable that death through starvation will be at least one factor in the coming increase in the death rate" (Ehrlich 1968,p.69). In a widely read book, William and Paul Paddock took an even more alarmist position: "All evidence shows that there is no possibility that sufficient new technology will be developed through research in time to avert widespread famine" (Paddock & Paddock 1967. p.78). " ... today's trends show that it will be beyond the resources of the U.S. to keep famine out of India during the 1970s. Indian agriculture is too antiquated. Its present government is too inefficient to inaugurate long-term agricultural development programs. Its population tidal wave is too overwhelming, more than 11,500,000 are added each year to the current half-billion population" (Paddock & Paddock 1967, p.217).

Amid these polarized debates, the eight-volume report sponsored by the Ford Foundation, the Second India Study, was the most comprehensive and systematic effort up to that time to foresee the consequences of a doubling of population -- for demography, urbanization, the economy, agriculture, water, energy, industry, and services. Each author considered events, constraints and achievements up through 1970 and constructed several plausible scenarios for the future until the year 2000 or beyond. All authors tried as best they could to link developments across sectors.

Since the doubling of India's population is now in sight, WRI and another team of eminent Indian experts have compared the scenarios of the Second India Study with actual

developments. The first objective in reassessing the Second India Study was to see to what extent the interplay of demographic, economic, and ecological change could be predicted. Today, optimistic and pessimistic but equally dogmatic pronouncements about the consequences of future population growth are still heard. Is such dogmatism justified? Can even serious scholars accurately foresee what adaptations to current constraints will emerge, or what new problems will materialize? What are the pitfalls of extrapolating current trends into the future?

The answers are mixed. In some areas, India continues to wrestle with many of the same problems today that were obvious in 1970. Managing water, forests, and other natural resources that form India's communal endowment is just as challenging today as it was then. In fact, Indian policy is once again devolving authority and responsibility to local government and community organizations, reversing a decades long centralizing trend. In urban areas, providing housing, water, sanitation, and other basic services to an expanding city population has proven to be every bit the problem that the Second India Study foresaw. So has been the challenge of generating jobs for a labor force doubling in size. In these respects, among others, the Second India Study's vision was accurate.

However, there were external shocks that have fundamentally changed the course o India's economy, which the Second India Study could not clearly foresee: the oil price shock that made India's energy-intensive heavy industrialization pattern irretrievably uneconomic; th accelerating globalization of the international economy, which invalidated India's inward-lookin import substitution strategy; the collapse of the Soviet Union and the switch to rapid marke

oriented growth in China, which undermined India's commitment to central planning and state dominated development and has led to the economic reforms initiated in the 1980s and still continuing. The Second India Study volumes traced out the implications of various assumptions about the future, but one assumption that was not questioned -- although it had the most far-reaching consequences -- was that India would continue under the centrally planned economic regime that had been established in the 1950s and 1960s. The gradual liberalization of that regime has been one of the factors enabling India's economic growth to accelerate over the last decade.

By and large, developments since the Second India Study was undertaken twenty years ago fall within the range of scenarios the authors thought plausible. In this sense, the middle ground taken by the Second India Study turned out to be the safer position. In general, progress in industrial and agricultural growth, poverty alleviation, and demographic transition has been nearer the pessimistic end of the range of forecasts, although the pace of development quickened significantly during the 1980s. However, there have been plenty of surprises and a few mysteries over two decades of experience. Among the surprises,

- By 1991 fertility rates in the South Indian States of Kerala and Tamil Nadu had reached replacement level or below, while rates in much of North India still exceeded five over the average woman's lifetime.
- Over India as a whole, natural fertility -- the number of births a non-contracepting woman would experience in a lifetime -- had risen from about six

to about nine, a 50 percent increase over roughly two decades.

- Despite the continuing shrinkage in agricultural land per person in the countryside, by the late 1980s the percentage of people below the poverty line was lower in rural villages than in cities.
- Throughout most of the period there were shortages of coal and coal-based electricity, though domestic reserves of coal are ample. By contrast, reserves and production of petroleum and natural gas, which were thought to be scarce, have greatly increased.

The Second India Study anticipated some problems that have not materialized. The authors greatly overestimated the resource requirements of India's economic development. They discounted the impact of new technologies that would be adopted, even in India's relatively closed economy. For example, virtually the entire steel industry converted from open hearth to electric arc furnaces, greatly reducing energy requirements. The cement industry shifted from wet to dry processes, with similar results. Also, the emphasis on heavy industry characteristic of India's development strategy in the 1960s was moderated. As a result, much less steel was needed for machine building, railway construction, and the like. Fewer railway lines and cars were needed to carry coal and less coal was needed to feed steam boilers and industrial furnaces. Even though India's economic policies during the period provided few incentives to conserve resources, structural and technological change nonetheless worked to that end. As a result, the environmental impacts and capital requirements of India's growth -- large as they turned out to be -- were substantially less than they would have been under Second India Study scenarios.

It is also true that problems have materialized that were not foreseen. In agriculture, for example, despite the optimism generated in the 1960s by the success of high yielding wheat and rise seed varieties, an extensive agricultural research effort in India has been unable to demonstrate continuing yield improvements for major crops over the 1970s and 1980s. Newly released seeds and agronomic input packages tested on farmers' fields have failed to show upward yield trends in the past two decades (please see Figure 1). Whether this represents deterioration in underlying soil fertility, weaknesses in the agricultural research effort, or genetic limitations in the plant materials available for use, is unclear. Whatever the cause, average farm yields continue to rise, but toward a static ceiling of demonstrated research results.

Overall, the record of the Second India Study teaches both the value of serious efforts to look ahead at the implications of massive population expansion and the need for a certain humility in making predictions. The Study did identify many of the key challenges that India would face and raised some of the key policy issues that policymakers needed to confront -- and, by and large, have confronted over the succeeding two decades.

II. The Main Trends and Interactions

Another objective in reexamining India's experience, using the Second India Study as a

benchmark, was to trace out the key interactions of population growth, economic development, and environmental stress over 20 years. The conclusions of the Second India Study, though varied, were basically optimistic that poverty and population growth could be reduced despite India's limited financial and natural resources. However, the authors emphasized that doing so depended not so much on the availability of technology as on solving difficult and long standing social and institutional problems.

These judgments were basically correct. The disasters predicted by Malthusian pessimists have not happened and India has continued to develop economically over the past two decades. But progress has been toward the low end of Second India Study projections, certainly much slower than hoped in the Government of India's various Five-Year Development Plans and slower than that observed in many other large developing countries in Asia.

The population growth rate between 1970 and 1990 was only very slightly lower than it had been during the previous two decades: 2.1 percent per year compared to 2.2 percent (please see Figure 2). The 1991 census counted 846 million Indians, almost as many as in the highest Second India Study projection of 849 million and 32 million people more than the lowest. By mid-1994, the Indian population had increased further, to about 900 million. The population increase since 1971, when it stood at 548 million, has been larger than the total increase in the six earlier decades of the 20th century (Srinivasan, p.1). In fact, if the people added to India's population since 1971 inhabited a country of their own, it would be the world's third most populous country, smaller than only China and India itself.

Near constancy in the growth rate masked the underlying demographic transition: crude birth rates and death rates did fall substantially, but in parallel. About 80 percent of the overall fertility decline is the consequence of more widespread use of birth control devices by married women. The percentage of couples using contraceptives rose from 10 to 40 percent over the period, largely through the efforts of the government supported family planning program. Per thousand of population, health personnel and clinical facilities expanded by 50 percent or more.

A key linkage with socioeconomic development has been the rise of natural fertility, which has historically been only about 6 live births per lifetime among Indian women. Despite the tradition of early and universal marriage, religious and cultural restrictions on sex, prohibitions against widows remarrying, prolonged breastfeeding, malnutrition, and the effects of malaria, tuberculosis and other diseases contributed to low natural fertility. Because many of these cultural practices have weakened, and because life expectancy and general health conditions have improved, natural fertility has risen substantially, to approximately 7 in the 1970s and 8 to 9 by 1991. Thus, India's decline in birth rates has occurred against a substantial rise in natural fertility, a consequence of economic development (Srinivasan, p.19-21).

What has emerged most strongly over the past 20 years since the Second India Study, is the importance of social and cultural determinants in the demographic transition -- especially women's place in the society (Basu, p.2-6). This is demonstrated dramatically in the variations from state to state within India in both birth and death rates and in their close association with

indicators of women's status -- such as female literacy (please see Figure 3). Fertility has fallen all across India, in villages as well as in cities, regional differences have become more pronounced. In a socio-economically backward northern Indian state such as Uttar Pradesh, where traditional attitudes persist and the women's status is low, the total fertility rate declined only from 5.9 to 5.1 between 1984 and 1991. In south India, fertility, which by 1984 had already dropped to 2.4 in Kerala and 3.3 in neighboring Tamil Nadu, fell further to 1.8 and 2.2, respectively -- replacement level or below.

Life expectancy at birth in India in 1990 had reached 60 years -- substantially as the Second India Study forecast. Although infant mortality rates have fallen, poverty related diseases stemming from high fertility, maternal malnutrition and exposure to respiratory and gastro-intestinal infections still predominate. Maternal mortality rates in India are still about 50 times higher than in high-income countries. In rural areas, only about one third of deliveries are attended by trained personnel in equipped facilities, -- although this ranges from 77 percent in Kerala to only 1.5 percent in Rajasthan (UNICEF, p.12-17).

Deaths to children under five accounted for nearly half of all deaths in 1971, but less than two fifths by 1986 and close to one-third by 1991 (World Bank 1993, Table A6). Although the majority of children still experience moderate or mild malnutrition, including debilitating vitamin, iron, or iodine deficiencies, the percentage of children suffering from severe malnutrition fell by half from the mid-70s to the late 1980s, in part because of governmental food distribution and child feeding programs (Bowonder, Food, p.20).

However, in the North Indian Hindi speaking states of Rajasthan, Haryana, Uttar Pradesh, and Madhya Pradesh, survival chances are considerably worse for girls than boys once infancy is passed. Little boys are given priority in feeding and medical expenditure; little girls must often make do with what's left over. In contrast to most other countries, India's population contains increasingly fewer females than males: 927 per thousand males in 1991, compared to 930 in 1971. In the large North Indian states where women are sequestered and discriminated against, including Bihar and the Punjab as well as those mentioned above, this sex imbalance is pronounced. Women's survival chances are lower and they may simply not be counted at census time (Basu, p.21; Srinivasan, p.6). Health surveys consistently find that when women get ill, they typically wait much longer before seeking medical help, if they do at all.

India's experience since the Second India Study demonstrates that both services and development are important in the demographic transition. India's expanding network of primary health centers and family planning clinics, its food distribution and nutrition interventions, its immunization and communicable disease control programs, and its investments in schooling and safe water supplies have helped lower mortality rates beneath those typical of countries at comparable income levels. But poverty, illiteracy, malnutrition, and unhealthy living conditions elevate death rates in many parts of India. Similarly, although the Government of India has sustained a massive family planning program, which has contributed to the fertility decline, the slow pace of economic development during the 1970s retarded the pace of demographic change, and the growing differences in birth rates among India's regions demonstrate the importance of modernization and social equity.

As the Second India Study had foreseen, between 1971 and 1991 the labor force increased to 123 million, growing faster than the total population. In the 1980's alone, it increased from some 290 to 350 million, which is 22 percent higher than the Second India Study projected. The employment problem turned out to be even more intractable than the Second India Study had anticipated.

The working age population (15 to 59) increased from 52 to 55 percent between 1971 and 1991, but the overall labor participation rate remained virtually unchanged at 41-42 population of the total population, implying that the percentage of working age people actually working has decreased. A larger proportion of young people are continuing their education. Moreover, even though female participation rates are rising in rural and urban areas, they are so much lower in urban areas that urbanization has reduced female labor force participation rates overall. Participation rates are 54 and 50 percent, respectively, for rural and urban males, and 34 and 14 percent for rural and urban females. In much of India, it remains more acceptable for females to work on their household farms or in family activities than outside the home.

Contrary to convential theories about population economics, India was able to raise its household savings rate significantly despite continuing rapid population growth, but low real returns on investment muted the impact on growth. Between 1970-1 and 1990-1, GDP growth in constant prices averaged 4 percent, toward the low end of Second India Study forecasts and no better than the average in the rest of the developed or developing world. There was, however, a substantial step-up from 3 percent in the 1970s to 5.3 percent in the 1980s (please

see Figure 4).

The dominant economic model of the 1960s presumed that in successful development experiences unproductive workers in agriculture would gradually be absorbed by rapid growth in other sectors. Because growth was slow until the 1980s and the capital labor ratio rose throughout the organized sectors of the economy and agriculture, formal employment opportunities failed to increase sufficiently to absorb new labor force entrants and cut into the enormous residue of underemployment. The economy seemed to be playing out the worst case scenario depicted by the Second India Study. Agriculture's share of the labor force fell only slightly, from 70 percent in 1970 to 65 percent in 1987/88, and the average value added per worker in agriculture fell from only 27 percent of that in the rest of the economy to less than one-quarter -- one reason why rural poverty persisted.

Agricultural production continued to rise at virtually the same trend growth rate observed in the 1950s and 1960s, even though the net cultivated area hasn't increased in the past two decades. The Green Revolution didn't fail, but neither has it produced a quantum increase in the growth of foodgrains output. Foodgrains production per capita has increased by only 5.4 percent despite 20 years of agricultural development efforts. Supplies have been adequate to meet market demand and to improve the diet of the average person somewhat, but overall calorie availability from all foods rose very modestly. According to available survey data, which is far from conclusive, the percentage of households with adequate protein and calorie intake increased between 1975 and 1989 in some states (including Gujarat, Madhya Pradesh and Orissa) but fell

on average slightly in the eight large states surveyed (Bowonder, Food, Tables 13-14), (please see Figure 14). Among children under five, an especially vulnerable group, the percentage suffering from severe or moderate undernutrition fell from 72 to 60 percent, according to survey data (UNICEF, Table 2.16). This improvement in a still unsatisfactory situation probably stemmed from lower birth rates, increased access to post-natal care and child health services, nutritional interventions through several public health and food distribution programs, and, especially, advances in the educational status of young mothers. Nutritional deficiencies in young children often stem from repeated bouts of diarrhea and respiratory infections, which impair their ability to absorb food even when they eat enough, so improvements in children's health care -- especially by their mothers -- is critical (UNICEF, p.29-30).

The Green Revolution really took hold in the alluvial river basins where tubewell irrigation during winter months was possible. It allowed production to continue expanding by increasing yields, mainly on irrigated or well-watered lands, even after the limits of cultivable acreage had been approached. Dryland agriculture has lagged further behind, so regional disparities in rural incomes have increased. Population growth supposedly acts as a spur to agricultural intensification. However, interregional differences in the growth of agricultural production had little to do with differences in population densities or population growth rates, and much to do with differentials in the pace of tubewell irrigation development (Vaidyanathan [a], p.24).

The total area under crops in India has remained nearly constant for the past 20 years. Any new lands brought under the plough just offset areas converted to other uses or lost to soil degradation. For example, about 8.5 million hectares, 6 percent of the cropland base, went out of production because of waterlogging, salinity, or excessive alkalinity. Gullying and erosion took other large areas. The modest 7 percent increase in the gross area cultivated stemmed entirely from increased double-cropping on irrigated farms (Vaidyanathan [a], p.23, Table 9). As the rural population grew, average farm size fell from 2.3 to 1.7 hectares between 1971 and 1986. By the late 1980s, over three quarters of all holdings were less than two hectares in size, and almost three fifths less than one hectare -- too small to provide fulltime livelihood or subsistence to an average sized family. At the same time, the number and total area in large holdings -- over 20 hectares -- also diminished (Bowonder, Food, p.21-23). Total landlessness in rural areas increased only slightly, and the concentration of agricultural land changed little.

In the Green Revolution areas, rising incomes have generated employment opportunities but pumpsets, tractors, and chemicals have replaced labor in farm operations, limiting the growth of farm employment. In lagging agricultural areas, where water is unavailable or poorly controlled, shrinking land-man ratios have exacerbated existing labor surpluses. A growing percentage of the rural labor force has had recourse to casual wage employment off the farm, some of it generated by governmental rural employment and other targeted anti-poverty schemes. After the national election of 1972, development policy shifted dramatically to attack poverty and underemployment directly through publicly funded employment creation, food distribution and anti-poverty programs, rather than relying on overall economic development.

By far the most encouraging labor market indicator is the improvement in real wages virtually throughout India since the GDP growth rate started to pick up (Hanson [a] 1990; Krishnan 1991). Even in the 1970s, agricultural real wage rates for males rose in all but four states (Punjab, Haryana, Maharashtra and Assam). Between 1980 and 1987, they rose in all major states and quite rapidly in some. Per day worked in Orissa, a man could support 1.9 persons at the poverty level for a day in 1970 and 2.5 people by 1987. In Madhya Pradesh, another poor state, these numbers were 1.8 and 3.2, respectively, and in a better off state such as Gujarat, 2.8 and 4.5.

Real agricultural wage rates for females moved upward even more consistently. In the 1970s, they declined only in Bihar, and in the 1980s only in Tamil Nadu. The median increase from the early 1970s to the mid 1980s was 2.7 and 1.8 percent per year for females and males, respectively. In 12 out of 15 states, the ratio between female and male wage rates improved, and the median ratio went up from .71 to .82. This change probably reflected the increased need for small farmers to seek off farm employment and the consequent tendency for their spouses to take over the farm work.

This evident rise in real wage rates, signalling some tightening of labor markets, is reflected in the data on poverty trends. The most commonly used poverty indicator, is simply the percentage of the population below the "poverty line." This measure omits a household's asset and debt position, its access to public and communal resources, and even the extent to which its expenditures fall short of the poverty line. The availability of publicly financed

services and of communal resources greatly affects the living standards of low income households. Fuels, fodder, and a variety of foods and materials gathered from the wild have traditionally met as much as one fourth of the total consumption needs in low income households. All over India, such communal resources have become scarcer but in some regions the situation is far more acute than in others. Since consumption and expenditure surveys don't capture diminished availability of such gathered resources perfectly, they understate the vulnerability of the rural poor and overstate any improvement in welfare.

An expert group instituted by the Planning Commission recently reviewed earlier poverty estimates and produced a revised set that the government has adopted. They show steady overall progress in reducing the prevalence of poverty in India, from 55 percent of the population in 1973 to 45 percent a decade later, and to 39 percent in 1987-88, the latest year for which National Sample Survey data are available (please see Figure 6). However, because of the population increase during these years, the number of people below the poverty line fell by less than 5 percent from 322 to 313 million between 1973 and 1988.

Rural and urban poverty trends converged over this period because the rural poverty rate fell almost twice as fast -- from 56 to 46 percent between 1973 and 1983 and then to 39 percent by 1988. In urban areas, where the poverty rate also declined from 49 percent in 1973 to 42 percent in 1983, it was still at 40 percent in 1988. By the late 1980s, not only had poverty become more prevalent in urban areas: the number of poor people in cities had increased by 23 million, almost 40 percent.

It is ironic that the Second India Study authors were gravely concerned about the urban bias in India's development patterns, which had created enormous disparities in living standards between citydwellers and villagers and which they saw as the source of an irresistible pull toward the cities. Their demographic prediction has been validated: over the past 20 years the urban population has doubled, increasing at twice the rate of the rural population (Mathur, p.6). Even the largest metropolitan areas, Bombay, Delhi, and Calcutta, have doubled in population. Although India's urbanization has not been particularly rapid by developing country standards, 100 million people have been added to the urban scene. And, the disparity between per capita production in rural and urban areas has widened. But, urban poverty has emerged as a growing, unanticipated problem.

Urban poverty increased partly because of rapid urban growth in poverty stricken states. Moreover, within the cities, poorer and less educated households tended to be those with the highest birth rates. Slow economic development, and, in particular, slow growth of industrial output and employment, failed to provide the engine that could pull the these rapidly increasing urban populations out of poverty. Industrial growth provides not only the direct factory employment, but also the ancillary opportunities in transportation, trade, construction, and other services that provide jobs for the urban poor. In urban areas, employment in large and medium-sized industries has also grown much more slowly than output, which itself has increased more slowly than in other developing Asian economies. Capital\labor and capital\output ratios rose in most Indian industries over the period. The fact that industry grew slowly and also became increasingly capital-intensive over most of this 20-year period, closed off opportunities to most

of the urban poor.

For these unfortunates, the quality of the environment can be a matter of life or death. The gap between the need for essential urban services and their availability has widened. Population densities in cities increased by 20 percent between 1971 and 1991, forcing up urban land values and making it increasingly difficult for low income households to find space. In the 23 largest cities, 28 percent of the people now live in squatter settlements, twice the percentage for all of India (Bowonder, Population, p.28). Housing in these settlements is typically makeshift, constructed from scrap material -- sometimes just rags and straw. Only one household in twenty in these "bustee" settlements enjoys a "pucca" house of permanent construction. Most of the squatter settlements are established on undesirable land -- subject to flooding, near heavily polluted industrial sites, or other hazards. Moreover, very few have sewers, drains, or facilities for collecting and disposing of garbage and other solid wastes -- ideal conditions for the spread of communicable diseases.

On the other hand, in some of the largest cities, such as Calcutta, the quality of life is better now than when the Second India Study was written. In particular, progress has also been made in providing access to safe water in Indian cities. According to official statistics, almost 90 percent of the urban population now has access to protected drinking water, compared to 78 percent in 1981, although for the urban poor the source is typically a public tap and supplies may not be sufficient (Mathur, Table 21). Yet, rivers and streams bordering urban settlements, still widely used for bathing and washing, are heavily polluted by human and industrial wastes,

as are shallow aquifers underlying cities, from which many households draw well water. In coastal cities that have overdrawn their groundwater supplies, such as Madras, the intrusion of saltwater into the aquifers has created serious water supply problems. Heavy pollution loadings and increasing urban population growth have compounded the problems of providing adequate water supplies.

Less progress has been made in the collection and treatment of human wastes, which can be inordinately expensive if conventional sewer systems and sewage treatment plants are used. Over half the urban population, 125 million people, have no access to basic sanitary facilities, but must make use of "open spaces" surrounding slum settlements (NIUA, cited in Mathur, Table 25). This fosters the spread of fecal-borne diseases, such as dysentery, hepatitis, helminthic infections, and cholera. According to 1988 data, in cities with populations of 100,000 or more, only 22 percent of the sewage generated was collected, and, of that, only 62 percent received primary and secondary treatment. Of the 241 towns with fewer than 100,000 inhabitants, which contain one third the urban population, only 19 have wastewater collection systems, and only 10 have treatment facilities (GOI Central Pollution Control Board, cited in Bowonder, Water, Tables 6-8).

The urban poor are exposed to other environmental hazards. Most still rely on fuelwood and biomass fuels, which they must purchase at rising prices in the marketplace. Women cooking with these fuels in tiny huts, using makeshift inefficient stoves, are exposed to incredible concentrations of smoke, as are their children: the consequences include high levels of

bronchitis and respiratory infections -- often fatal in malnourished young children -- and chronic eye irritation and infections. So many squatter settlements are clustered in industrial areas, along roadways, and in other congested urban areas that the urban poor are highly exposed to air pollution from vehicles and industries. In the 20 years since the Second India Study, the number of vehicles on the road in India has increased tenfold and city traffic jams are commonplace. Two thirds of the vehicles on the road, almost all in urban areas, are two-wheel motor rickshaws and scooters powered by high emissions two-stroke engines. Poorly maintained buses and trucks spew forth highly toxic diesel emissions. Gasoline in India still contains lead, and lead concentrations found in samples taken from India's children are extremely high. Exposure to lead impairs children's mental development.

These environmental hazards are particularly dangerous to the urban poor because they compound the problems of malnutrition, general ill-health, and the lack of medical care. The well known interplay of diarrhea, weight loss, and malnutrition, and vulnerability to respiratory infection is a deadly cycle to which many Indian children succumb. To this must be added the risks of exposure to high concentrations of air pollutants, known to have more serious harmful effects on those whose respiratory functions are already impaired. As a result, infant mortality rates in urban slums in 1989 were 123 per thousand, compared to the all India rate of 98, the overall urban rate of 62, and an infant mortality rate of 22 among urban households above the poverty line (Srinivasan, Table 7; Mathur, Table 26).

This overwhelming burden of sickness cannot but lower the productivity and earnings of adults who must work every day for a living, and perpetuates poverty in these unhealthy environments. Women in particular, who suffer from inferior access to health care and even to food, but who nonetheless must work long hours, are soon debilitated. Children, who also suffer chronic sickness, malnutrition, and vitamin deficiency, cannot attend school and learn effectively if they are sick and hungry, so their hopes of escaping poverty's trap are also undermined.

In most respects, India's rural environment has deteriorated markedly since the Second India Study was written. In canal- irrigated areas, dams are rapidly silting up because of deforestation upstream, and millions of hectares of farmland have become waterlogged or salinized because water has been applied improperly. In large areas where tubewell development has been intensive, water tables are falling; in coastal areas, salt water is invading and ruining the aquifers, depriving tens of millions of people of drinking and irrigation water.

Much of India's farmland has long been deficient in nutrients and organic matter. Organic matter is rapidly oxidized in the heat, leached or eroded away during monsoon rains, or removed through repeated cropping and burning of plant and animal residues. Yet, because of the rural energy deficit, the quantity of organic manures applied in India declined by 20 to 25 percent between 1975 and 1991. The runoff of eroded topsoil into India's rivers and estuaries estimated at around 25 billion tons per year, contains nutrients equivalent to all the chemical fertilizers used in the country. Even though chemical fertilizer use is growing rapidly,

micronutrient deficiencies have emerged as important constraints on plant growth in much of India: large percentages of soil samples are deficient in such elements as zinc, iron, and copper (Bowonder, Environmental Trends, p.6). Thus, the additional crop output obtained from increases in chemical fertilizer use declined substantially over the period, even though farmers have become more familiar with chemical fertilizer and improved seed varieties and despite the spread of irrigation.

Pesticide use rose 6 percent annually over the period. Nearly 70 percent of the pesticides used in India, including DDT, aldrin, methyl parathion, and BHC, are banned or severely restricted for agricultural uses on health grounds in some other countries (Center for Science and the Environment 1985, cited in Joshi & Singh, p.97). There are no comprehensive systems for monitoring exposure levels or comprehensive data on health impacts, but local surveys give clear warning signs. In the Punjab, the leading agricultural state, pesticide contamination of food was pervasive in the 1970s, especially in milk and dairy products. Seventy-three percent of milk samples from Ludhiana District found excessive DDT residues, averaging five times the legally permitted level. Even mothers' milk contained DDT and BHC residues several times higher than permitted levels. In a Punjabi cotton-growing district, DDT intake through mother's milk was 24 times the acceptable daily intake. Use of these compounds continues to increase (Dhaliwal & Diliwari, p.193-94). Recent findings implicating these estrogen-mimicking compounds to reproductive disorders are grounds for substantial concern (Colburn & Clement 1992). More powerful and toxic organophosphates such as methyl parathion have also come into use. Although these substances break down faster and do not accumulate in tissues as DDT

does, their use involves both acute and chronic health risks. In a more recent study in an urban market in Rajasthan, 40 percent of vegetable samples were contaminated with organophosphates (Gupta 1990, cited in Joshi and Singh). Since these pesticides may impair the human immune response, they are potentially dangerous to malnourished children subject to repeated infections, since the immune systems of such children are already stressed. This syndrome illustrates the complex linkages among poverty, demographic factors, and the environment.

In the uncultivated parts of rural India, two thirds of the total area, overharvesting of fuelwood and overgrazing of livestock -- combined with unsustainable rates of commercial exploitation -- have devegetated the landscape. Neither central nor state government authorities have been able to ration access to these communal resources effectively and equitably. Large-scale soil erosion and disruption of hydrological flows have resulted. Increasing shortages of fuelwood, fodder, and other useful products of India's commons have added to the deprivations of the rural poor, especially women, who are most dependent on those resources (please see Figure 7). Most of India's varied native ecosystems now exist only in remnant patches, under great pressure from surrounding populations and commercial interests. Shrinking habitats have reduced the numbers and the ranges of India's magnificent and diverse plants, animal and bird populations, endangering many.

III. Vicious and Virtuous Circles

Participants in the original Second India Study saw the diverging paths towards India's future, some leading toward development and prosperity but others leading to deeper poverty and degradation. They emphasized that steps in either direction would be self-reinforcing, propelling the nation down one path or the other. As Hannan Ezekiel, the author of the overview volume, put it, "I was deeply impressed by two things. One was the existence of vicious or virtuous circles of interaction having profound implications for the likely state of the economy at the end of the period. The other was the critical role of policy in determining whether these relationships would, in fact, operate to produce vicious or virtuous circles..."

The overall interplay between population, poverty, and resource availability was described in such terms. Here is his description of the dark scenario: "Income will grow slowly. Population will grow rapidly. Per capita income will, therefore, grow very slowly. This will have a negative impact on family planning efforts ... Also, savings ratios will not rise and may even fall. ... Industrial growth will be slow. Growth in industrial employment will be even slower. ...The existing land hunger will increase. Further subdivision and fragmentation of land will take place. Propagation of new techniques of cultivation will become more difficult... In this context, talk of social justice will be mere nonsense. The proportion of the population below the poverty line will certainly increase.... The employment situation will also worsen and it may well be that the ability of the socioeconomic system to cover it up in various forms ... will prove to be inadequate. ... Communal, caste, regional or economic groups will fight with one another with increasing bitterness in order to obtain for themselves a share of the limited real resources, income and employment available in the country" (Ezekiel 1975, Overview,

p.189-190).

While this dark vision finds some reflection in events in India since the early 1970s, the striking trend is the increasing differentiation of development patterns. While some regions stagnate, others move briskly ahead. In fact, both virtuous and vicious circles are evident in India's diverse regions. In Kerala, for example, women have long enjoyed better status and opportunity. Women obtained more education and married later. They gained greater access to professional and other socially sanctioned employment, which cemented their position and authority within the household. For all these reasons, contraceptive use and fertility decline took hold early in Kerala. This, in turn, allowed women to pursue education and career more easily, and increased their social status and economic opportunity. Today, 85 percent of Kerala's women are literate, the infant mortality rate is comparable to that in New York City and fertility is below replacement level.

By contrast, in northern and northwestern states, such as Rajasthan, women typically married outside their own villages and were secluded within their husbands' household, virtually excluded from paid employment except in extreme circumstances. Status came from mothering sons. Girls received little education, married early, and commenced childbearing. With little autonomy or education, most women's opportunities outside the home were virtually nil. Thus, their social status remained low, and few girls received more than rudimentary education. Marriage age stayed low, and birth rates continued high. In Rajasthan today, only 20 percent

of women are literate, only 30 percent of married couples practice contraception, and the average married women has five to six children.

Other vicious and virtuous circles affect India's environment and resources. The British colonial government assumed authority over almost all of India's forests and uncultivated regions, all but abrogating the traditional rights and regimes of village communities, tribal societies, and other groups that had used these resources -- more or less sustainably -- for generations. After Independence, succeeding central and state governments were largely unable to restrain access to this vast domain in the face of rising populations and demands for raw materials. When demands surpassed sustainable yields, a cycle of depletion and degradation was set in motion. Seeing others taking the increasingly scarce resources without stint, none saw reason to restrain their own demands. Thus overexploited stocks and harvests shrank as population and demands on what remained intensified. As the value of communal resources deteriorated, village leaders increasingly withdrew from attempts to manage what remained, leaving the rural poor to glean what they could from the ever-shrinking woodlands and pastures.

In a few areas, the cycle has been interrupted and reversed. Communities assured of equitable and exclusive use of the commons have limited overexploitation and cooperated in rehabitation programs. Investments in restoration have raised productivity, diminishing the pressure to overexploit the resource. Higher returns have provided the resources for further investments, leading to further increases in productivity. Although only in exceptional instances has the notorious "tragedy of the commons" thus been reversed, these promising examples have

led to a needed reexamination of development policies.

IV. The Primacy of Institutions and of Policies

The authors of the Second India Study made clear their views that India had the power to choose options that would generate employment, reduce poverty, accelerate the demographic transition, and avert resource crises. They emphasized that neither the technology available at that time nor the availability of natural resources precluded India from raising living standards for a doubled population. The agricultural technologies needed to double yields and production on both dry and irrigated farmland existed then. India also possessed enough energy resources to meet the needs of cities, industries, and villages.

According to the Second India Study, by choosing policies that spurred rapid employment growth, government could deal effectively with poverty and malnutrition within the economic system, rather than by attempting to mitigate the failures of economic development through special anti-poverty interventions. By reducing poverty and investing heavily in education and health, the government could ensure the success of the family planning program and accelerate the demographic transition. By promoting community woodlots, biogas plants, and rural electrification, the government could provide enough fuel and forage to relieve pressure on India's common property resources. By better managing water resources and by integrating surface and groundwater systems, India could expand its irrigated area without

environmental damage. The question was whether India would choose these successful options.

A look back over the past twenty years confirms the correctness of this point of view. Neither technologies nor resources have been the intractable problems. Rather, where development has faltered, the stumbling blocks have usually been institutional and policy related. The key issue has often turned out to be that of creating mechanisms, whether through market incentives, community organizations, or other means of governance, for bringing the interests of the individual into line with those of the broader community. Where this has happened, the circles have been virtuous; where it has not, the circles have been vicious and the dynamics destructive and unsustainable.

In family planning, the government has continued to emphasize the technologies of birth control, first the IUD, then male and female sterilization. An extensive service network has been constructed to provide these technologies throughout India, with substantial impact on those ready to terminate childbearing. However, what has become increasingly evident is the importance of social institutions that, afford women social status, autonomy, and opportunity -- not only to regulate their fertility but to satisfy their health, economic and social needs as well. In parts of India, where women can fulfill these needs, their own interests in family planning coincide with those of the larger community.

In other realms, similar findings emerge. For example, persistent energy shortages have indeed robbed India of badly needed output and employment, depriving the urban and rural poor

alike. But, neither technology nor natural resources have been constraining. India has large coal reserves and far more oil and gas than was suspected twenty-five years ago. One reason for scarcities of commercial fuels has been the failure to price energy high enough to ration demand and generate funds for reinvestment. Another reason has been continued reliance on inefficient public sector monopolies. In rural areas, renewable energy technologies and potential biomass resources have been available, but too few resources have been allocated to meet the energy needs of the rural poor, and too few community governance structures have been built and supported to reverse the notorious tragedy of the commons.

In agriculture, India has successfully promoted the use of its underground water resources and the new Green Revolution technology to meet its food requirements. Where farmers could invest in electric or diesel powered tubewells, and control their own water supplies, the use of modern agricultural technologies has paid off, and farmers have rapidly increased their yields and incomes. Local water markets have emerged through which those without wells could share in the benefits. By contrast, in large canal irrigation systems, where the interests of farmers come into conflict, politicized irrigation administrations have been unable to allocate water efficiently and equitably. Compared to tubewells, canal irrigation still remains typically unreliable or inadequate and has increased agricultural yields much less.

Moreover, because groundwater exploitation was heavily subsidized on a first-come, first-served basis, the better off farmers were allowed control of an immensely valuable resource at virtually no cost, and an opportunity was missed to allocate more rural assets and income to

small farmers and agricultural workers. Where water scarcities emerged, the absence of any effective means to limit the individual farmer's withdrawals has led to depletion or ecological damage. By concentrating its fiscal resources heavily on the alluvial areas where tubewells were advantageous, the government put the lagging dryland and flood prone regions at a disadvantage, allowing rural income disparities to widen.

The evidence that has emerged in India over the 20 years since the Second India Study was carried out suggests that a rapid demographic transition, poverty alleviation, and development can occur simultaneously even in poor and populous countries. But unsustainable spirals of population growth, environmental degradation and impoverishment are also possible. Population growth such as India's makes it harder to reduce underemployment and poverty, raise educational levels and environmental quality, or provide adequate infrastructure and basic services, but it doesn't make these tasks impossible. The key determinants of success seem to lie in the social framework, broadly conceived to include the system of norms, economic arrangements, policies, and institutions of governance.

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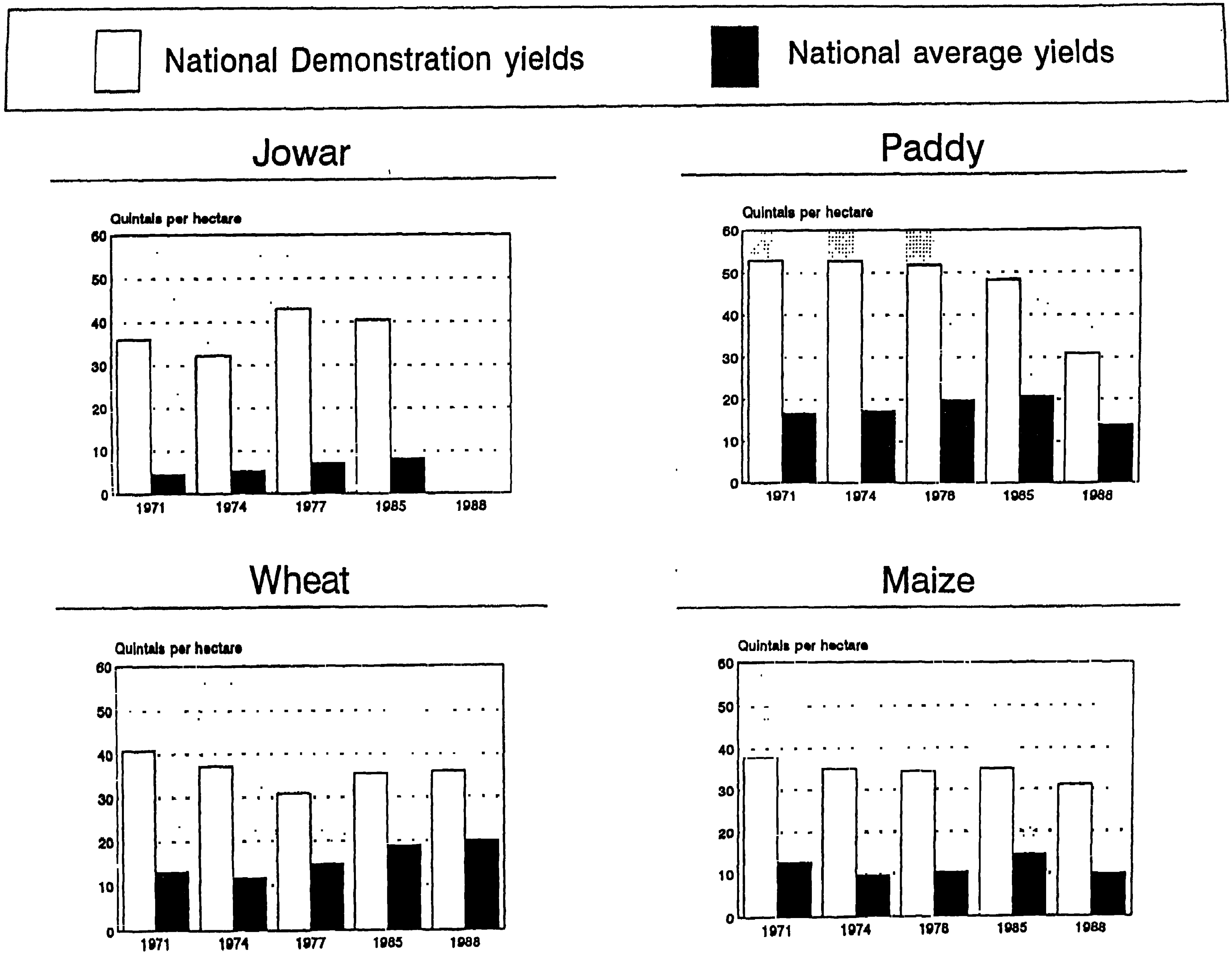
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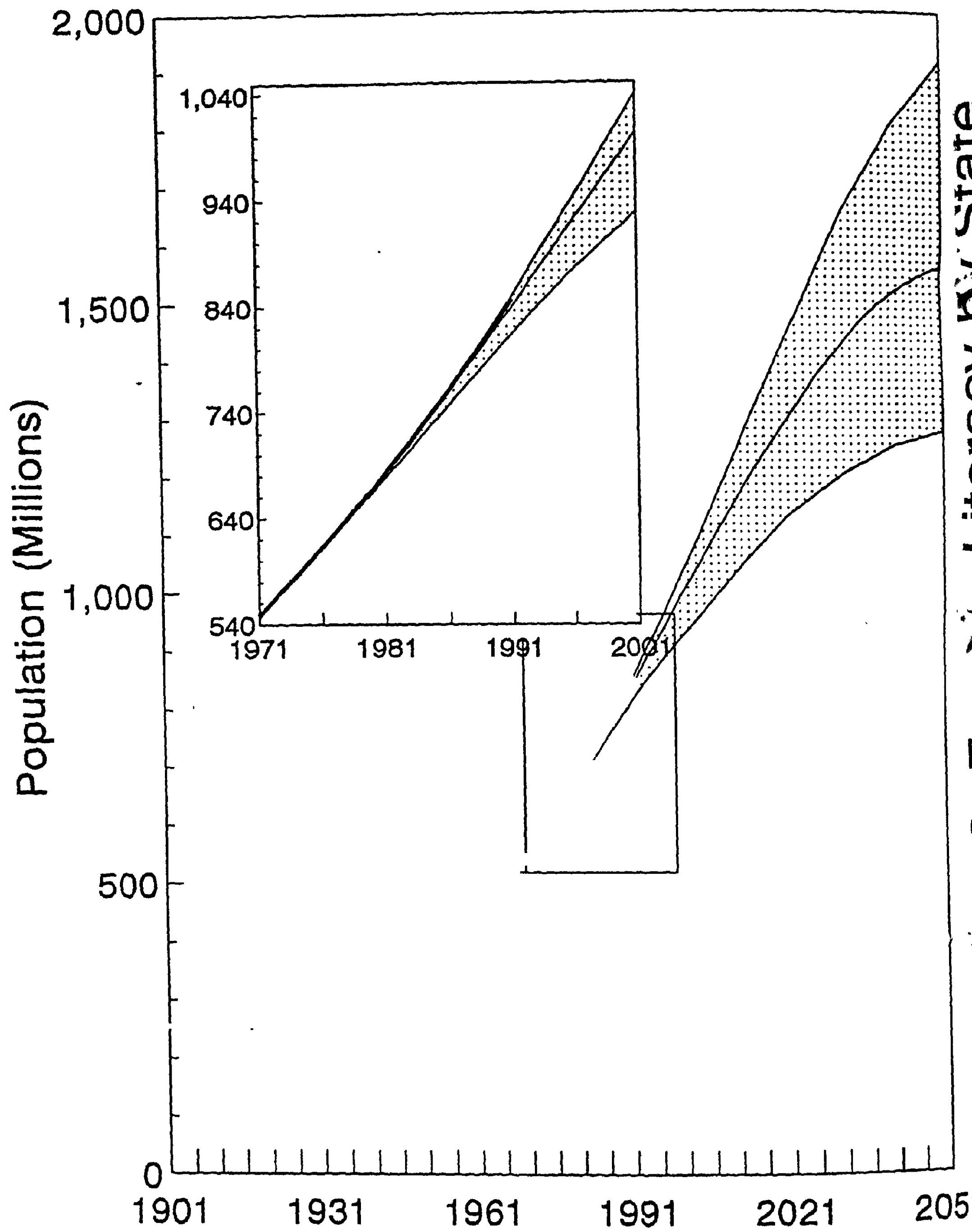
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Source: Vaidyanathan (1993); Table 5

Figure 2 Population Growth

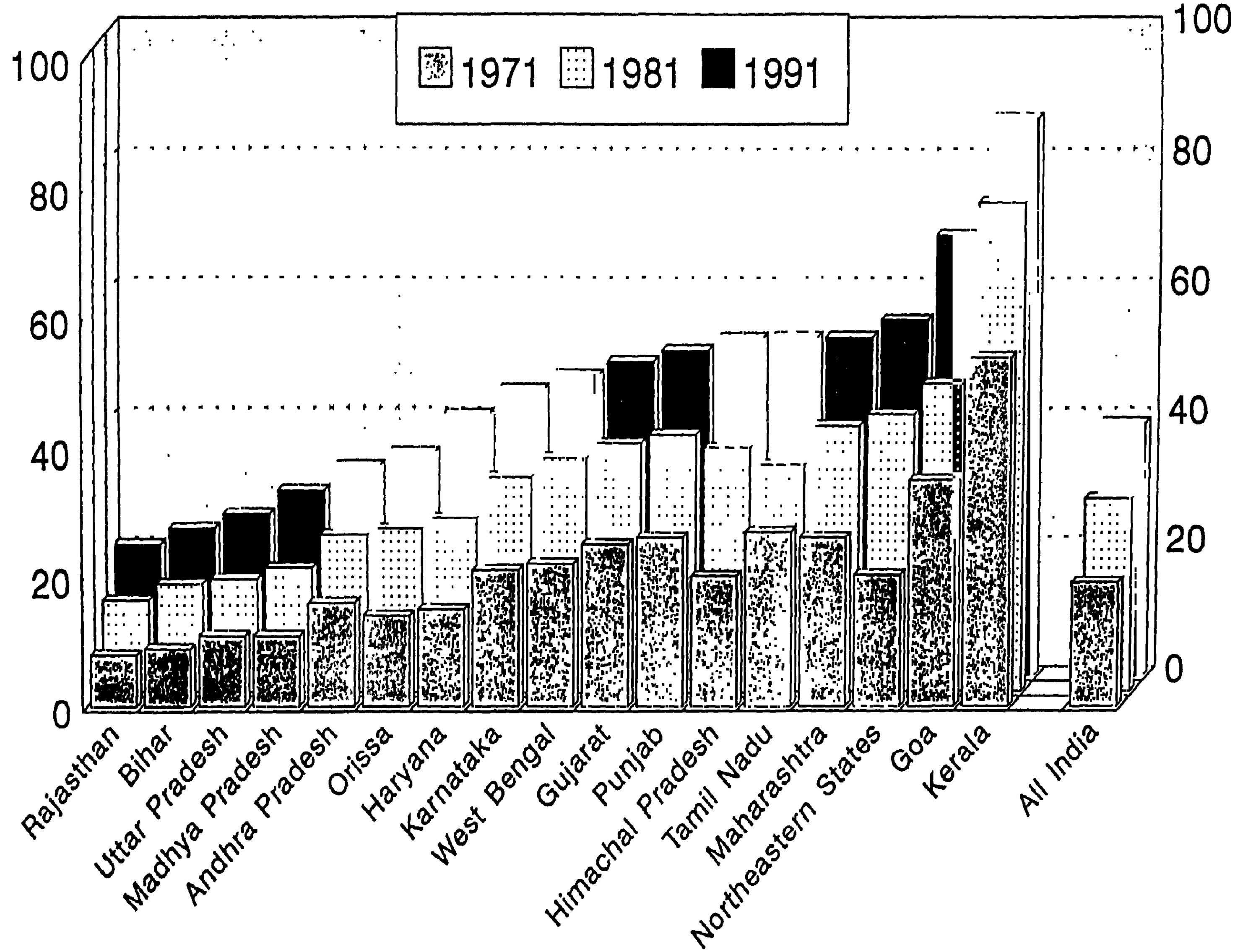


Shaded area represents range of projections. Bold line is actual grow

Sources: Ambannavar (1975), Second India Studies: Population; GOI, 1991 Census, in Bowonder (1993).

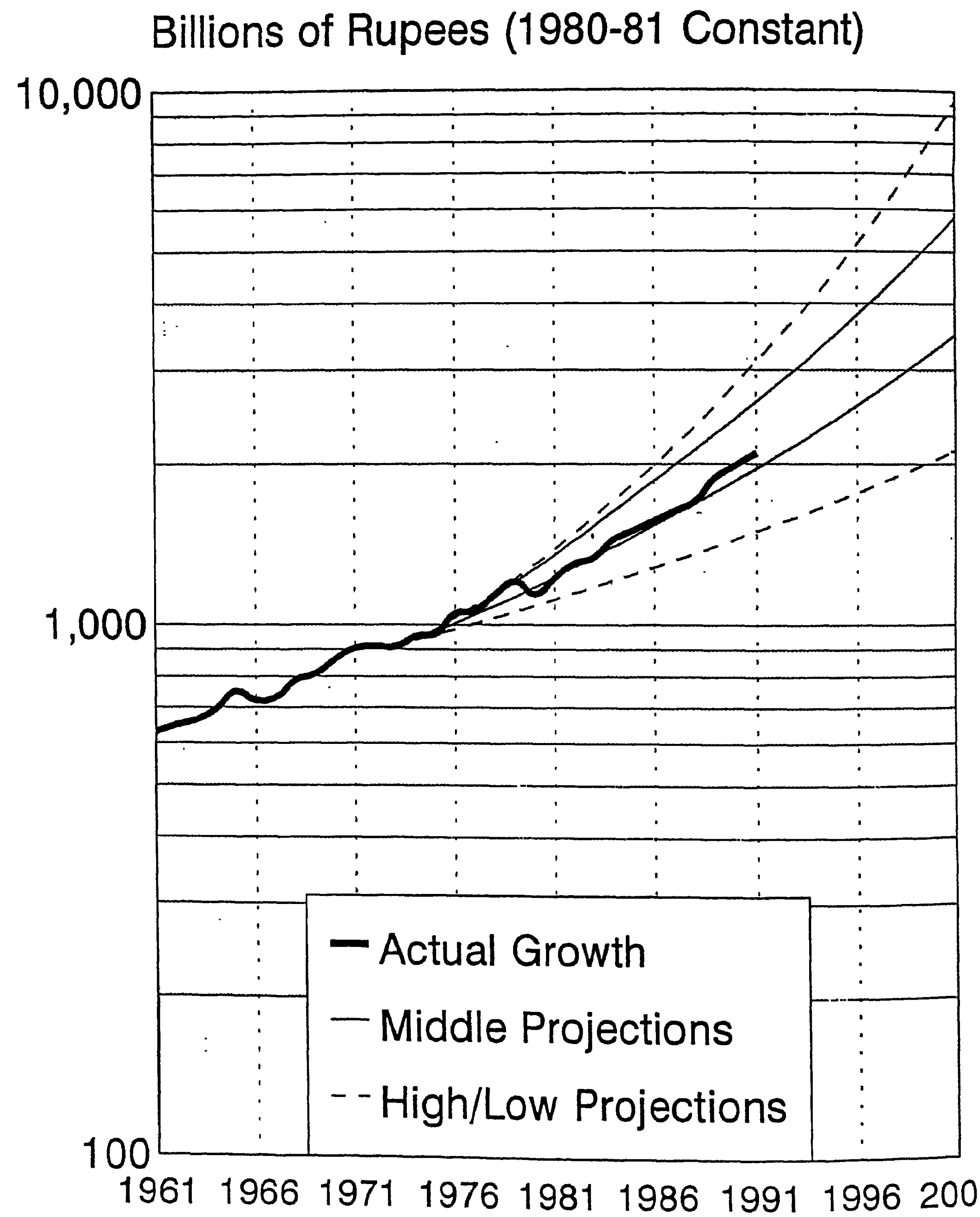
Figure 3 Female Literacy by State

Female Literacy Rate (Percent)



Sources: GOI, 1971 Census; GOI, 1991 Census

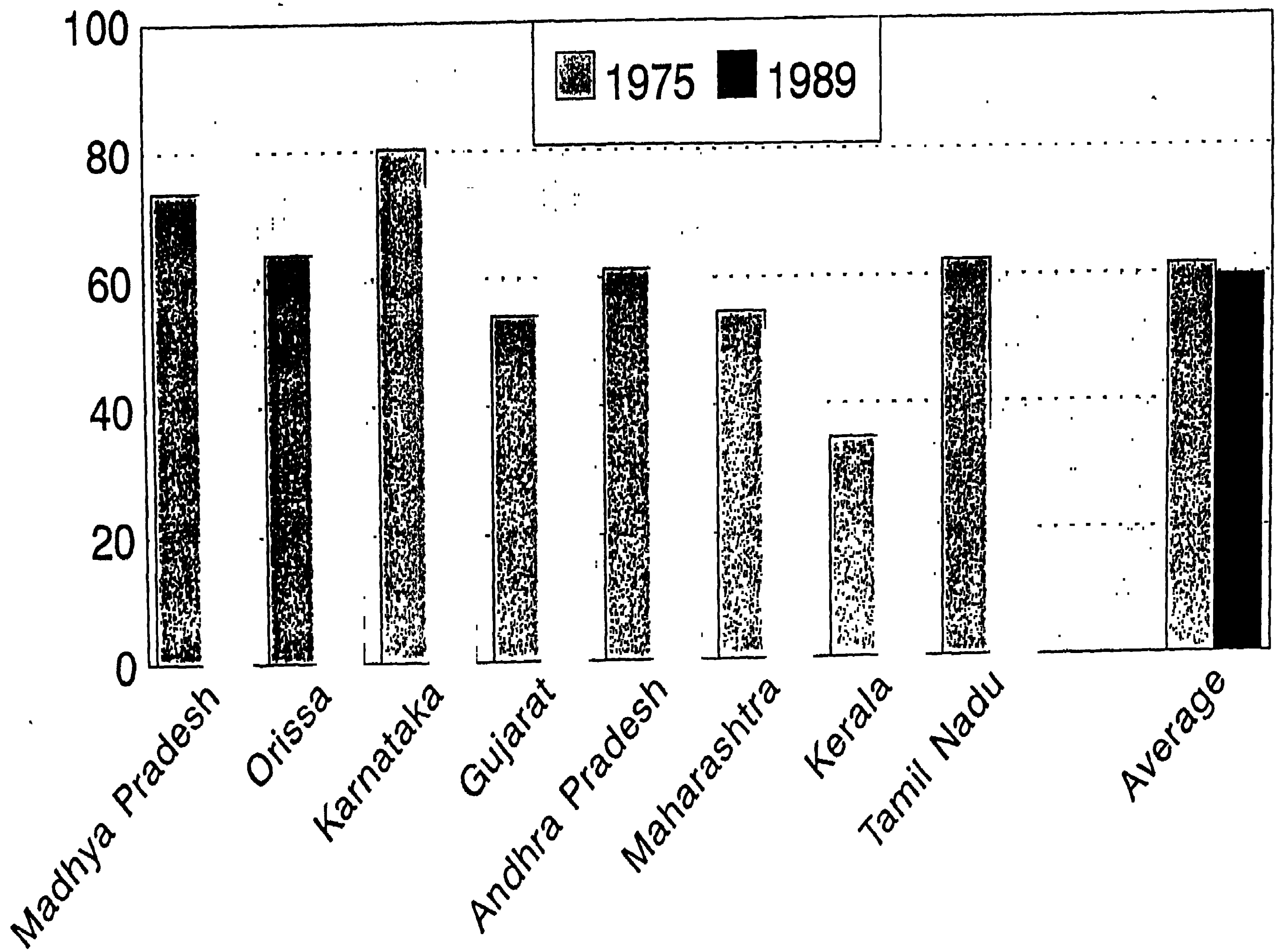
Figure 4 Gross Domestic Product SIS Projections vs. Actual Growth



Sources: Mehta (1976), Second India Studies: Economy; GOI (1993) National Accounts

Figure 5 Calorie and Protein Intake Adequacy in Selected States

Percentage of Households with Adequate Protein and Calories



Source: GOI, National Nutrition Monitoring Bureau, in UNICEF (1991)

Figure 6 Poverty Prevalence By State

Percent of Population Below Poverty Line

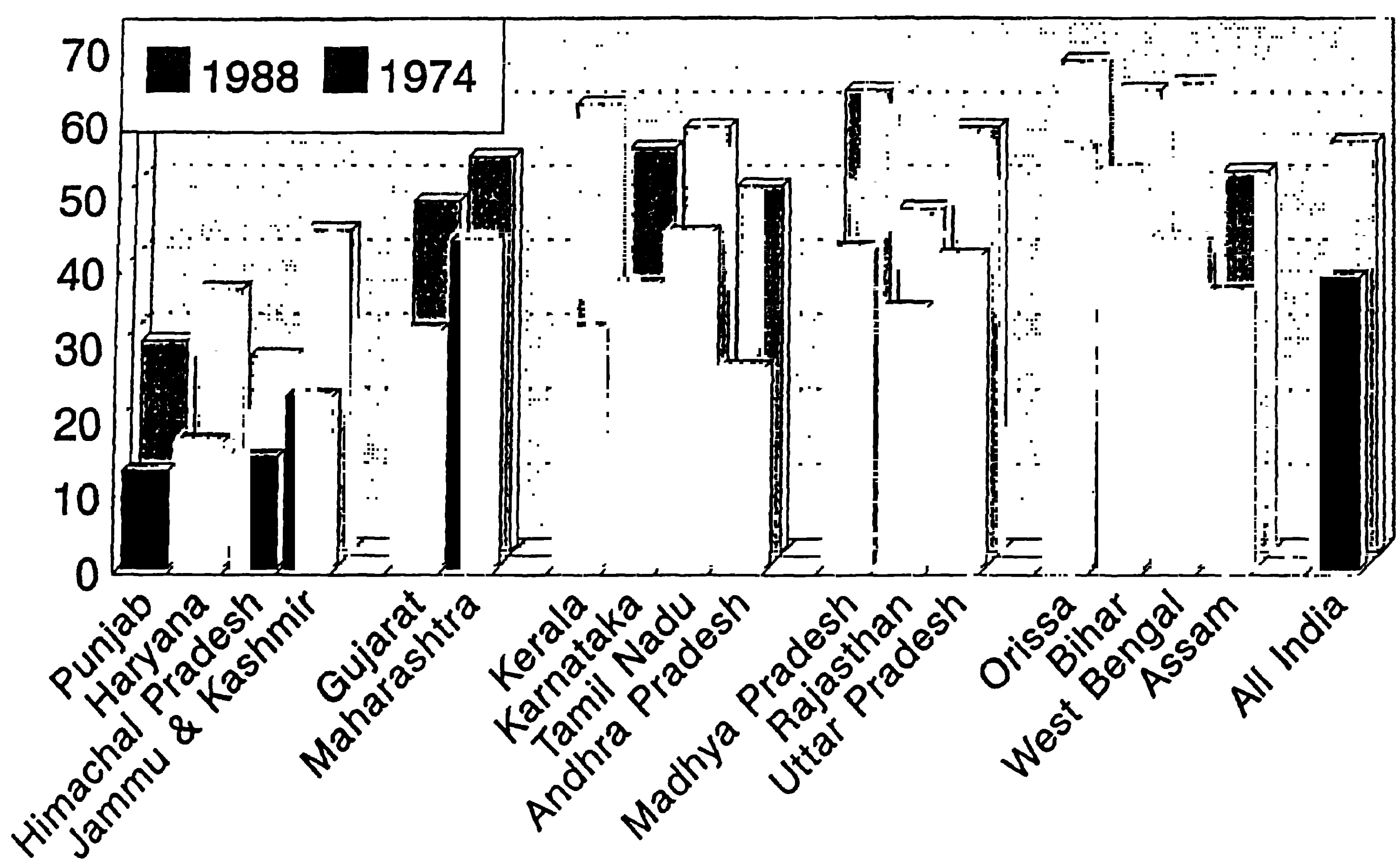
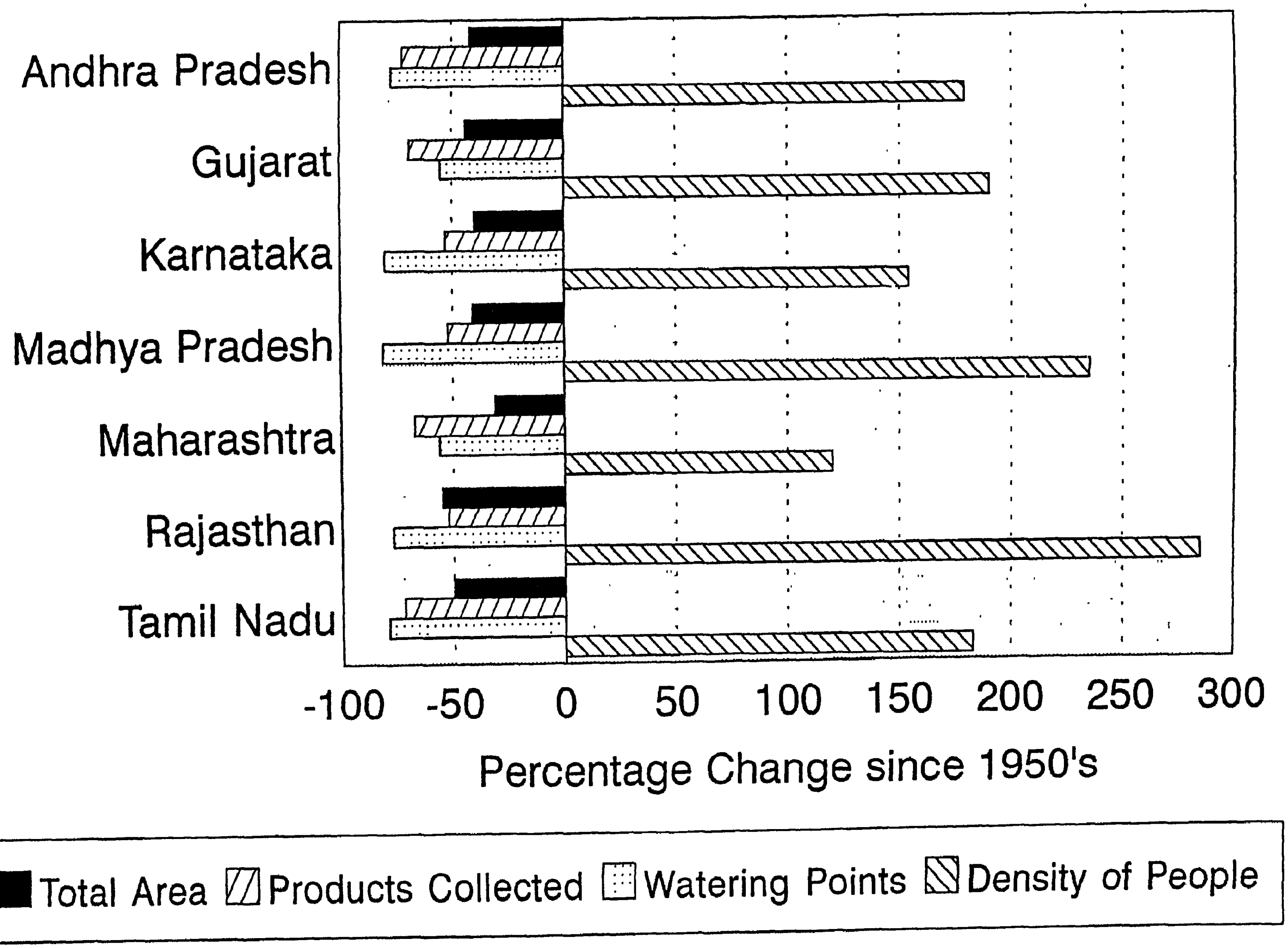


Figure 7 Decline of Common Property Areas



Products collected include fruits, flowers, leaves, roots, timber, fuel, etc.
Watering points include grazing CPRs only.

Source: Jodha (1992); Table 6

Population, Development and Environmental Conditions at the Village Level During 1981-1991: An Empirical Study Using Census Data in Kota District of Rajasthan State, India

Submitted by
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by

K. Srinivasan & Sanjay Kumar

Introduction.

Kota is a district of Rajasthan located in the south-eastern part of the state and is a medium sized district with an enumerated population 2.03 million as per the 1991 census. In 1992, after the census, the district was bifurcated into two districts, Kota and Baran, with minor boundary adjustments from the neighbouring districts and the population of the bifurcated Kota district is 1.22 million. In this article which attempts to study the demographic, developmental and environmental conditions at the village level, we confine our attention to the undivided district of Kota with a population of 2.03 million.

A basic demographic profile of the district and the state of Rajasthan for comparison purposes is given in Table 1. The district had in 1991, 36.4% of its population living in urban areas compared to 22.9% in the state as a whole. It had a literacy rate of 64.0% and 29.5% among males and females aged 7 and above compared to 55.0% and 20.4% in the state as a whole. It had a decadal growth rate of 32.3% compared to 28.4% in the state during the decade 1981-1991. The relative Index of Development of the district, as computed by the Centre for the

Monitoring of Indian Economy (CMIE, 1995) based on a number of developmental parameters was 119 compared to 69 for the state as whole. Kota is thus one of the most urbanized , industrialized and economically advanced districts adjudged from the macro level conditions in the state. The newly formed district of Kota, is even more urban and industrialized than the undivided Kota district. Kota symbolizes the nature of changes that are to come in other districts of the state of Rajasthan and possibly in other states with the accelerating pace of industrialization set in motion in the country during the past five years. It will be interesting to study the nature of changes that have occurred in the villages of Kota district especially from the point of view of developmental and environmental conditions at the village level and if possible draw lessons from such an analysis , that may be useful in the planning of developmental strategies in the rural and urban areas.

The nature of industrialization initiated in the district of Kota are largely stone cutting and polishing (Kota district is famous for its black granite stones), coloring and twisting of synthetic fibre yarns, auxilliary parts for automobile industries etc., in which the workers employed do not need much education. Illiterate men and women can get gainful employment in many of these industries by learning their skills on their jobs, and many times doing their jobs from their homes. Thus it has been possible to have a substantial increase in employment in the non-agricultural sector in this district for even rural populations

living in villages and traditionally employed in the agricultural sector. For example crude granites are delivered at home for cutting and polishing by the workers and when the cut and polished stones are received the wages are paid. In such a situation one need not find any strong positive association between literacy levels and employment in the non- agricultural sector at the village level, as is often assumed in economic analysis of development, at least in the early stages of development. Similarly, without increase in the educational levels of the population, especially of the females, and the urban facilities of cooking gas and electricity available in the households, it is possible that the traditional practice of using wood for heating and cooking purposes would continue even with the populations engaged in the non-agricultural sector in the rural areas. Consequently, with the increase in the population size in the rural areas due to high fertility levels prevalent in these areas, it is possible that the common property land holdings in the villages or the 'culturable waste', as they are called, would decrease in proportion to the land area because of the need for larger areas to be brought under cultivation to feed the growing populations. The 'culturable waste', as it is called, is a part of the common property of a village community and is used by the rural poor, especially those without any land of their own, for grazing their cattle, raising some fodder or fruit trees and can be considered as the buffer to the very poor in the rural areas. With the growth of the wealth of the agricultural

land owners consequent to the green revolution and bringing larger and larger cultivable areas of the village under irrigation, there is an increasing demand for the land under 'culturable waste' to be brought under cultivation and to become a private property. In many other cases it can also be used for construction of houses to meet the needs of the growing population (Jodha, 1989; Ranjan, 1996). A reduction in the 'cultivable waste' can be considered as an indicator of environmental stress of the society. Such a stress can be caused by demographic and developmental factors of the population. Similarly the proportion of forest lands to the total land area, in areas where there are declared forests, may also decline because of the use of such forests for cutting fire wood for cooking and heating purposes. With regard to forests, it is possible that there can be a reduction in the density of forests without any change in the declared forest area but such a change is hard to measure from any secondary data sources. Thus we can postulate the following four hypothesis:

1) Development, both economic and social, will be influenced by the population size of the village because of the possibilities of location of schools and other infrastructural facilities in large sized villages;
2) At the village level there would be significant positive association between the proportion of labour force employed in the non-agricultural sector and literacy levels among

males and females though such a relationship may not be strong;

3) At the village level there will be a significant negative association between the common property land or the 'culturable waste' and the economic and social development and this may be unrelated to the population size;

4) The proportion of forest land to the total land area of the villages will be negatively and significantly correlated with the social and economic development and population pressures.

Data Sources

The census of India, conducted in 1981 and 1991, have published information at the village level,as a part of the Primary census Abstract, on a few parameters that permit analysis of the current situation and decadal changes on selected demographic, developmental and environmental conditions of the district at the village level. Among the variables on which data were available, information on the following were compiled for the villages of Kota district for 1981 and 1991 for the testing of the above hypotheses.

1) Population size at the village level in 1981 and 1991 (POPT81, POPT91)

2) Percentage of the labour force (main workers) employed in the non-agricultural sector -

   In total population (NAGT81, NAGT91)

   In male population (NAGM81, NAGM91)

In female population (NAGF81, NAGF91)

3) Percentage of total land area of the village brought under irrigation (IRR81, IRR91)

4) Percentage of the total land area of the village in cultivable waste (CUW81 , CUW91)

5) Percentage of the land area under forest (FOR81, FOR91)

6) Percentage of the population who are literate -

Among total (LITP81, LITP91)

Among men (LITM81, LITM91)

Among women (LITF81, LITF91).

For 1991 the literacy rate is based on population aged 7 and above, while for 1981 it is based on the total population. Hence comparison of literacy rate between 1981 and 1991 has to be done with caution.

Using the above variables an analysis of the relationship among them was carried out using correlations and multivariate analysis to test the above mentioned hypotheses. The findings are presented below.

Analysis and Findings

Data were available on all the above ten variables for 1367 villages of Kota district for 1981 and for 1593 villages for 1991. For 1225 villages data were available on all the variables for both the census years facilitating comparison.

Table 2 presents the mean values of the selected variables of the villages classified by their population size. The

variables included are, Population density per square Km.(POPDEN), culturable waste as a percentage of the total land area of the village (CUW), percentage of the irrigated land to the total land area of the village (IRR), percentage of the main workers engaged in non-agricultural activities (NAGM, NAGF and NAGT for males , females and the total respectively), percentage of the population found literate (FLIT, MLIT and PLIT for females, males and total for 1991 based on those aged seven and above and based on the whole population for 1981). With regard to the population size, the villages have been grouped into five categories: 'very small' (less than 250 persons), 'small' (250 to 499 persons), 'average' (500 to 749), 'large' (750 to 999) 'very large' (1000 and above). From the table we can see that the 'small' and 'very small' villages have significantly declined in number and total population in them. The number of very small villages declined from 243 to 159 and their share of the rural population from 20.1% to 13.1% during the decade 1981-91. The social and economic conditions of villages classified as 'small' or 'very small' are significantly lower than the 'average', 'large' and 'very large' villages. This is true both for 1981 and 1991 as well as for economic and social conditions. For example the mean of the percentages of village land under irrigation in 'very small' and 'small' sized village were 9.95 and 14.29 compared 18.89 and 22.77 for the 'large' and 'very large' villages in 1981. In 1991 the means were 15.71 and 20.07 in 'small' villages compared to 28.51 and 31.01 for the 'large'

villages. The percentage of the females literate in 1991 were 6.68 and 8.51 in the 'very small' and 'small' villages compared to 11.72 and 15.91 in 'large' and 'very large' villages. The data clearly reveals that the level and pace of development of the villages are considerably influenced by their population size. This can be explained from the fact that the location of schools, roads, markets and other infrastructural facilities are likely to be associated with size of the village. Smaller villages are grossly lagging behind than others in all aspects of development. Special developmental strategies have to be adopted for such villages (Hypothesis 1).

Table 3 presents data on the mean values of selected indicators of villages classified by the level of 'culturable waste': 'very low' (less than 4%), 'low' (4 to 7.9%), 'average' (8 to 11.9%), 'high' (12 to 15.9%) and 'very high' (16 % and over). The table reveals that the villages with higher proportion of 'culturable waste' have generally lower levels of development in terms of female literacy, proportion of area under irrigation and the percentage of male workers employed in the non-agricultural sector. For example, the mean value of the percentage of males employed in non-agricultural sector decreases across higher 'culturable waste' land villages from 14.80 to 11.84 with an exception of average 'culturable waste' land category of villages.

Table 4 presents data on the mean values of selected indicators for villages classified according to the proportion of

females literate in the population aged 7 and above in 1991. The table reveals that the proportion of 'culturable waste' in the village seems to be negatively related to the literacy level of the village. For e.g. the percent of 'culturable waste' in villages with 'high' female literacy (20% and above) was 8.24% compared to 11.62 in 'very low' literacy villages (less than 5%). In other words as there is social development, the environmental stress on the village seems to increase with a decline in the common property resources or the 'culturable waste'. On the other hand with an increase in the female literacy of the village, there is an economic development as is seen from the increasing proportion of the irrigated land to the total area of the village. In the 'very high' female literacy villages (20% and above) 31.93 percentage of the land was under irrigation while only 15.22% of the land was under irrigation in the 'very low' literacy villages (less than 5%). Similarly the proportion employed in the non-agricultural sector in the villages are very strongly and positively associated with the level of female literacy in the village. Thus at the village level social and economic development seem to go hand in hand and both seem to contribute to the environmental stress.

The zero order correlation matrix among the above variables for the years 1981 and 1991 with their statistical significance are furnished in Tables 5 A and 5 B. The data for Table 5 A is based on 1367 villages while for Table 5 B on 1593 villages. From these two tables it can be seen that the nature of the

relationships among the variables have remained the same in 1981 and 1991, with a few minor exceptions. The correlation between area under irrigation (IRR) and the population employed in the non-agricultural sector for both males and females (NAGM81, NAGF81) which were not significant in 1981 turned up to be negatively significant for the females employed in the non-agricultural sector in 1991, (-0.1078). Similar finding is observed with regard to the relationship between proportion of land under cultivable waste and the population employed in the non-agricultural sector (CUW and NAGF) wherein the relationship that was significant in 1981 (-0.0854) turned out to be not significant in 1991. The most important finding observed from these two correlation tables is the low level of correlation coefficients between literacy levels and the proportions employed in the non-agricultural sector : + 0.1384, +0.1057,and +0.1733 in 1981 and +0.1832, +0.0.0652 and +0.1920 in 1991 for men, women and the total population respectively. Though these coefficients are statistically significant because of the large sample size, being the number of villages in the district, 1367 in 1981 and 1593 in 1991 in the analysis, and in the right direction, all being positive because of their low values, the female literacy rate is capable of explaining less than 4% (r-squared values) of the variance in the non-agricultural employment level. Our analysis for the state taking district as unit of analysis regarding the relationship between female literacy and employment in the non-agricultural sector in the rural areas yielded a

statistically insignificant correlation coefficient in 1991. One would normally have expected a much stronger relationship between the levels of literacy and employment in the non-agricultural sector at the village or district level but this is not the case within Kota district (Hypothesis 2).

The association between the land area under irrigation and employment is insignificant and positive in 1981 but has changed directions in 1991, though significant only in the case of female employment in the non-agricultural sector. This indicates that increased employment diversification is tending to be associated with lowered land area under irrigation in the recent years. It is likely that persons employed in the non-agricultural sector may, atleast in some cases, neglect intensive cultivation of their lands, because of the higher wages received from their non-agricultural occupations.

A multivariate analysis relating the 'cultivable waste' (CUW)
as the dependant variable with selected other predictors was carried out for 1991 data. The cultivable waste was used as an indicator of environmental stress variable that demands use of all available area for cultivation or for other utilitarian purposes such as housing. Lower this proportion greater will be the stress on the available land area. The predictive factors used were : population density (POPDEN) as a demographic pressure, female literacy rate (LITF) as an index of social development, area under irrigation (IRR),as an index of economic

development of the agricultural population and percentage of male labour force employed in the non-agricultural sector (NAGM) as an index of occupational diversification. The following results were observed when analysed for all villages :

CUW= 11.609+0.851*POPDEN-0.078*FLIT-0.078*IRR-0.042*NAGM ...(1)

R-squared=.054 with R and all the regression coefficients statistically significant at .0001 level.

To examine the role of population size, POPDEN variable was replaced by POPT in the multivariate analysis. The following results were obtained :

CUW= 12.074+0.001*POPT-0.089*FLIT-0.071*IRR-0.042*NAGM ...(2)

R-squared=.049 with R and all the regression coefficients statistically significant at .0001 level.

The regression coefficients in equations (1) and (2) above are almost the same excepting for the population variable wherein the coefficient for POPT or population size is smaller than for population density but both are significant and in the right direction.

The above analysis pertains to all the villages in the district of Kota irrespective of the fact whether they have a forest or not and are based on the levels of the predictors and the dependant variable as on 1991. It will be interesting to

study the effects of the same predictors separately for the villages with declared forest area within them.

Table 6A and 6B present the zero order correlation coefficients of selected variable for the villages having declared forest area. (714 and 770 villages in 1981 and 1991). The proportion of land under forest (FOR) is significantly and negatively associated with CUW, IRR, FLIT and POPDEN in both the years. The magnitude of the coefficients have declined between 1981 and 1991, excepting in the case of female literacy (FLIT). The NAGM which was not significant in its association with FOR became significant in 1991. With occupational diversification dependance on the forest seems to go down at the village level. A multivariate analysis relating FOR with other predictors for 1991 led to the following results:

$$FOR=58.50-7.94*POPDEN-0.80*CUW+0.24*NAGM-0.63*IRR-0.33*FLIT \quad ..(3)$$

R-squared= 0.38 which is highly significant and all the beta coefficients are also highly significant.

The same set of demographic and developmental variables seem to explain a higher proportion of the variance in the 'forest area' than in 'culturable waste' in all villages, given in equation 1.

Interpretation of the Results

From the foregoing analysis, which can be considered as a first step in an understanding of the changes taking place at the

village level in the context of industrialization and urbanization, the following tentative conclusions can be drawn:

1) The levels and pace of social and economic development at the village level seems to be significantly influenced by the population size of the village. This is true both for social and economic development as well as for 1981 and 1991. Separate developmental strategies seem to be called for the 'very small' and 'small' villages with populations less than 500.

2) The economic and social development seem to move together and adversely affect the proportion of land under 'cultivable waste', creating environmental stresses. Between 1981 and 1991 the percentage of 'culturable waste'(CUW) has declined from a mean of 11.28% to 10.22% of the land area in the villages indicating decline in the common property resources at the village level.

3) The villages with declared forests seem to be adversely affected with regard to their land area under 'forest' with social and economic development, as indicated by improvements in literacy (FLIT) and land area under irrigation (IRR); however in 1991 we found that the occupational diversification at the village level has positive association with land under forests. People engaged in non-agricultural sector in rural areas may not deplete the forest land. We do not know whether the forests are

depleted, within a given forest area, as we do not have the needed data on the density of forests.

4) The multivariate regression analysis revealed that the same developmental variables were able to explain a much larger proportion of the variability in 'FOR' as the dependant variable in forest villages than in 'CUW' in the combined analysis of all the villages. (R -squared 38% compared to 5%).

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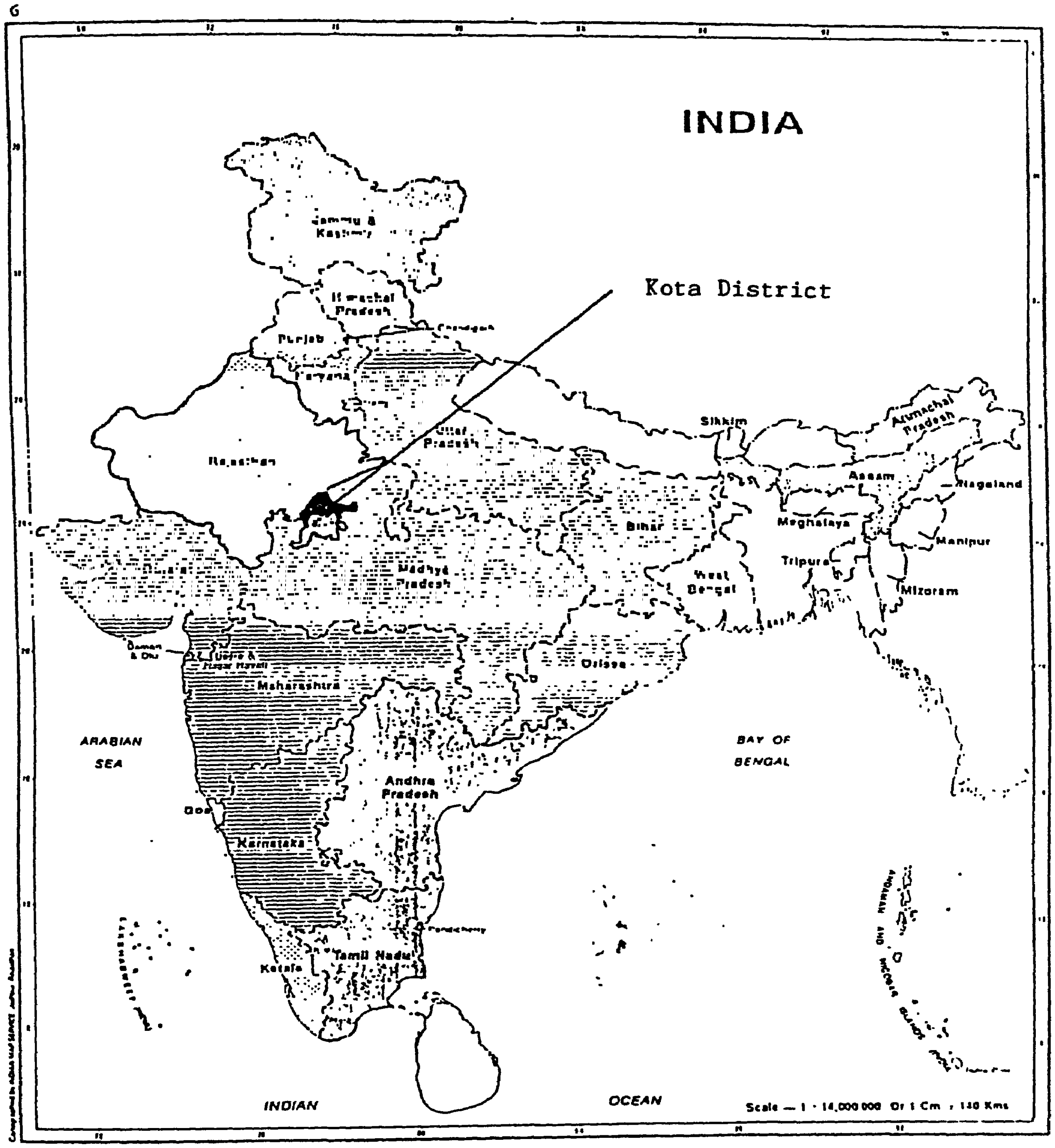

INDIA
Kota District
Jammu & Kashmir
Himachal Pradesh
Punjab
Haryana
Rajasthan
Uttar Pradesh
Sikkim
Arunachal Pradesh
Assam
Nagaland
Meghalaya
Manipur
Bihar
Tripura
West Bengal
Mizoram
Madhya Pradesh
Daman & Diu
Orissa
Maharashtra
ARABIAN SEA
BAY OF BENGAL
Andhra Pradesh
Goa
Karnataka
Pondicherry
Tamil Nadu
Kerala
INDIAN
OCEAN

Table 1 : A Comparative Profile of Kota district and Rajasthan (1991)

	KOTA	RAJASTHAN
Land Area (sq. km.)	12,436	342,230
<u>Population</u>		
Total	2,030,831	44,005,990
Males	1,076,184	23,042,780
Females	954,647	20,963,210
Rural	1,290,996	33,938,877
Urban	739,835	10,067,113
Exponential Growth Rate (annum) (%)	2.63	2.50
Decadal Growth Rate	+32.32	+28.44
Density of Population (per sq. km.)	163	129
% District to Total Population of State	4.61	—
Percent of Urban Population	36.43	22.88
Percent of SC Population	19.72	17.29
Percent of ST Population	14.20	12.44
Sex Ratio (f/m)	887	910
Percent of Main Workers to Total Population	31.41	31.62
Number of Villages	2101	39,810
Number of Inhabited Villages	1881	37,889
Number of Towns	12	222
Relative Index of Development (CMIE, 1995)	119	69
<u>Literacy Rates</u>		
Total	47.88	38.55
Males	64 03	54.99
Females	29 50	20 44

Table2 : MEAN VALUE OF THE SELECTED VARIABLES ACROSS DIFFERENT POPULATION SIZE CATEGORIES VILLAGES, KOTA, 1981 & 1991.

VARIABLE	POPULATION SIZE CLASS OF THE VILLAGES					
	All villages	< 250 (Very Small)	250 - 499 (Small)	500 - 749 (Average)	750 - 999 (Large)	1000 and Above (very large)
POPDEN(Per sq. Km.)						
1981	120	67	107	123	142	194
1991	150	66	123	150	158	221
CUW						
1981	11.28	12.27	11.72	10.25	11.02	10.83
1991	10.22	10.86	10.29	9.83	9.57	10.55
IRR						
1981	16.47	9.95	14.29	19.58	18.89	22.77
1991	24.43	15.71	20.07	25.16	28.51	31.01
NAGM						
1981	15.59	11.56	12.67	14.58	15.42	27.20
1991	13.88	9.70	9.92	11.94	11.69	23.73
NAGF						
1981	18.47	12.81	18.33	21.39	14.18	24.46
1991	11.83	7.77	9.20	14.83	8.47	16.32
NAGT						
1981	15.25	11.26	12.93	14.55	14.01	25.93
1991	12.79	9.05	9.11	11.22	10.49	21.76
FLIT						
1981	5.51	3.50	4.38	5.38	5.66	10.04
1991	10.94	6.68	8.51	10.52	11.72	15.91
MLIT						
1981	32.17	32.26	30.11	35.66	37.02	41.36
1991	47.91	31.88	42.17	50.14	53.86	57.53
PLIT						
1981	19.49	12.91	17.86	21.23	22.09	26.45
1991	30.48	20.03	26.33	31.49	33.94	37.88
No.of Villages						
1981	1225	243	386	259	130	207
1991	1225	159	332	266	175	293

Table 3 : MEAN VALUE OF THE SELECTED VARIABLES ACROSS DIFFERENT CATEGORIES OF CULTURABLE WASTE VILLAGES, KOTA, 1981 & 1991.

VARIABLE	PERCENT OF CULTURABLE WASTE TO TOTAL AREA OF THE VILLAGE					
	All villages	< 4 % (Very Low)	4 - 7.9 % (Low)	8 - 11.9% (Average)	12 -15.9% (High)	16% and Above (Very High)
POPDEN (Per Sq. km)						
1981	121	126	104	114	131	137
1991	150	156	130	146	172	168
IRR						
1981	16.47	21.74	17.32	16.32	15.41	11.60
1991	24.43	30.97	24.46	25.54	21.01	15.43
NAGM						
1981	15.59	18.98	15.50	16.58	15.80	11.52
1991	13.88	14.80	13.79	15.07	13.40	11.84
NAGF						
1981	18.47	24.87	19.95	17.74	17.65	10.08
1991	11.83	11.51	11.25	12.17	10.73	13.65
NAGT						
1981	15.25	19.19	15.22	16.22	15.50	10.62
1991	12.79	13.70	12.83	13 68	11.81	11.17
FLIT						
1981*	5.51	5.84	6.12	6.24	5.53	3.57
1991	10 94	10.78	12.36	12 26	9.47	8.02
MLIT						
1981*	32.17	30.75	34.91	34 20	32.82	27.05
1991	47 91	45.61	51.73	51.67	46.76	40.41
PLIT						
1981*	19 49	18 95	21.25	20 81	19 80	15.95
1991	30 48	29.19	33.13	33 13	29 05	25 28
No of Villages						
1981	1225	214	362	269	172	244
1991	1225	262	369	244	142	208

* Based on the whole population

Table 4 : MEAN VALUE OF THE SELECTED VARIABLES ACROSS DIFFERENT CATEGORIES OF FEMALE LITERACY VILLAGES, KOTA, 1991.

VARIABLE	FEMALE LITERACY					
	All villages	< 5 % (Very Low)	5 - 9.9 % (Low)	10 - 14.9% (Average)	15 - 19.9% (High)	20% and Above (Very High)
POPDEN 1991	150	122	152	160	176	181
CUW 1991	10.22	11.62	10.81	9.61	8.60	8.24
IRR 1991	24.43	15.22	25.01	28.80	35.53	31.93
NAGM 1991	13.88	9.60	12.17	15.32	15.53	22.29
NAGF 1991	11.83	10.81	12.87	12.69	7.43	14.69
NAGT 1991	12.79	9.21	11.26	13.93	13.72	20.24
MLIT 1991	47.91	29.09	48.93	56.75	61.58	68.98
PLIT 1991	30.48	16.35	29.26	35.82	40.52	49 85
No. of Villages 1991	1225	441	243	193	132	215

Table 5A Correlation Matrix, Kota,1981(For All Villages, N=1367))

	IRR81	CUW81	MLIT81	FLIT81	PLIT81	NAGM81	NAGF81	NAGT81	POPDEN81	POPT81
IRR81	1.0000									
CUW81	-.1519**	1 0000								
MLIT81	.2277**	-.1522**	1 0000							
FLIT81	.1154**	-.1310**	.5639**	1.0000						
PLIT81	.2181**	-.1617**	.9640**	.7444**	1 0000					
NAGM81	.0088	- 0875*	.1384**	.2386**	.1886**	1 0000				
NAGF81	.0154	-.0854*	0802*	.1057**	.1019**	.5760**	1.0000			
NAGT81	.0122	.0930**	.1224**	.2291**	.1733**	.9842**	.6454**	1.0000		
POPDEN81	.2599**	.0410	.2658**	.1992**	.2654**	.2443**	.2107**	.2428**	1.0000	
POPT81	.1354**	-.0310	.3536**	.3682**	.3974**	.3536**	.1292**	.3248**	.3706**	1.0000

2 - tailed Signif: * -- .01 ** - .001

Table 5B : Correlation Matrix, Kota, 1991 (For All Villages, N=1593)

	IRR91	CUW91	MLIT91	FLIT91	PLIT91	NAGM91	NAGF91	NAGT91	POPDEN91	POPT91
IRR91	1.0000									
CUW91	-.1965**	1 0000								
MLIT91	.3169**	-.1359**	1 0000							
FLIT91	.1838**	-.1256**	.6917**	1.0000						
PLIT91	.2961**	-.1406**	.9711**	.8385**	1.0000					
NAGM91	-.0131	-.0631*	.1832**	.2793**	.2289**	1.0000				
NAGF91	-.1078**	.0107	.0190	.0652*	.0378	.5722**	1.0000			
NAGT91	-.0268	-.0607*	.1475**	.2469**	.1920**	.9868**	.6441**	1.0000		
POPDEN91	.2360**	.0102	.2516**	.2049**	.2561**	.2884**	.1556**	.2786 **	1.0000	
POPT91	.1241**	-.0011	.3022**	.3506**	.3406**	.4025**	.1367**	.3813**	.3963**	1.0000

2 - tailed Signif : * -- .01 ** - 001

Table 6A : Correlation Matrix, Kota,1981(For Forest Villages, N= 714)

	FOR81	CUW81	IRR81	FLIT81	NMAGM81	POPDEN81
FOR81	1.0000					
CUW81	-.3114 **	1.0000				
IRR81	-.3637**	-.1215*	1.0000			
FLIT81	-.1588**	-.1460**	.2711**	1.0000		
NAGM81	.0575	-.1402**	.0496	2611**	1.0000	
POPDEN81	-.4401**	.0912	.3122**	.2532**	.2055**	1.0000

2 - tailed Signif: * -- .01 ** - .001

Table 6B : Correlation Matrix, Kota,1991(For Forest Villages, N=770)

	FOR91	CUW91	IRR91	FLIT91	NAGM91	POPDEN91
FOR91	1.0000					
CUW91	-.2871**	1.0000				
IRR91	-.3962**	-.1489**	1.0000			
FLIT91	-.1820**	-.1163*	.2182**	1.0000		
NAGM91	1113*	-.0982*	.0253	.2697**	1 0000	
POPDEN91	-3854**	.0433	.2784**	2558**	2042**	1 0000

2 - tailed Signif * - 01 ** - .001

Population and Environment Interrelationships: The Case of Nepal

Submitted by
Bhim P Subedi

Population and Environment Interrelationships: The Case of Nepal

Bhim P. Subedi

Introduction

Much has been written about population growth, fertility and the prescription of technical fix in Nepal (e.g. CBS, 1987, 1995; Banister and Thapa, 1981; KC, 1993; Gurung, 1989; Joshi, 1993; Tuladhar et al., 1977; HMG/N, 1992). Likewise, there is no dearth of literature on environment, eco-crisis and the blaming on human actions (e.g. Eckholm, 1976; IUCN, 1992; HMG, 1993; WECS, 1990). However, our understanding of population-environment interrelationships in Nepal is very poor and attempt to understand the complexity has just begun. In this context, this paper attempts to provide a national scenario of population growth and its impact in the environment. The paper begins with conceptual aspects of population-environment interrelations and presents the case of Nepal. The growth of population is discussed first followed by regional disparity, land use changes, deforestation, changing crop production and cropping intensity respectively. Despite overwhelming impression of negative impact of population growth in the environment, there are indications of positive changes in the country. The extent of environmental changes taking place in the country needs to be assessed in the context of historical background, geology and changing access to the resources.

In the context of increasing size of population, meeting human needs and enhancing the quality of life i.e. development, requires important demands on the environment. It is people who make the demand and in terms of sustainable development people should recognize that the limits of sustainability have structural as well as natural origins (Redclift, 1991). Chambers (1986) pointed out that environment and development are means not end in themselves and that environment and development are for people, and not people for environment and development. Thus, there is a clear link between population, environment, and sustainable development. Keeping a balance between productive potential of ecosystem with a minimal or no damage of its environment and increase in human welfare which can cope with increasing numbers is a very critical issue of contemporary society. A focus on production increase to cope with increasing population should ensure that production itself does not degrade resources beyond a certain point and regenerative capacity.

The Interrelationships

The interrelationship between population and environment is complex and this complexity is further reinforced by the numerous dimensions of each factor. The impact is mutually reinforcing. People modify their environment, the population in turn is also affected by changes in the environmental conditions. The interdependence between them is so critical that human beings cannot exist without environment and environment does not have any meaning without people. While the interrelationships unfold over space through time, the socioeconomic context play an important role in mediating the relationships.

Misunderstandings surround our knowledge of the interrelationships between population and environment. Attempts to understand the interrelationships have just begun (see Ehrlich et al, 1993; UNEP, 1993; ESCAP, 1993). The overall impression is such that over time population increases and its increased size puts pressure on the environment and its resources beyond their regenerative capacity. There has been a presumption that the impact of population growth is always negative. These notions are too simplistic and that they are distortions of reality.

In recent years, there has been an increased realization that the issue of population is not only about its size but also about its structure, quality, and pattern of distribution. Population size alone is not the sole factor for environmental changes, it is the consumption level, utilization pattern, and the technology that play a vital role in the overall environmental changes of an area. This in turn is related to the socio-economic structure of the society. In a similar manner, the institutions primarily political, social, and economic have important say in the overall changes of the environment.

The literature suggests two major viewpoints about the exact relationships of population growth and environmental changes. Ehrlich and Ehrlich (1990) take a view that environmental deterioration is the direct consequence of population growth. They argue that population growth causes a disproportionate negative impact on the environment and that redistributing population would be a dangerous pseudo solution to the population problem. In their earlier publication, Ehrlich and Holdren (1971) suggested that the total impact of a society on the eco-system can be expressed as:

$$I = P.* F.$$

where **I** stands for total impact; **P** means population size; and **F** stands for impact per capita.

Commoner et al (1971), view that population plays a role in the environmental deterioration, however it is not the major detriment of the environmental crisis. For them other variables such as technology play a much more significant role in the ecological crisis. Accordingly, technological changes are more important than mere population size and the impact per capita. Thus, the interrelationship of population and environment can be expressed as:

$$I = P * A * T$$

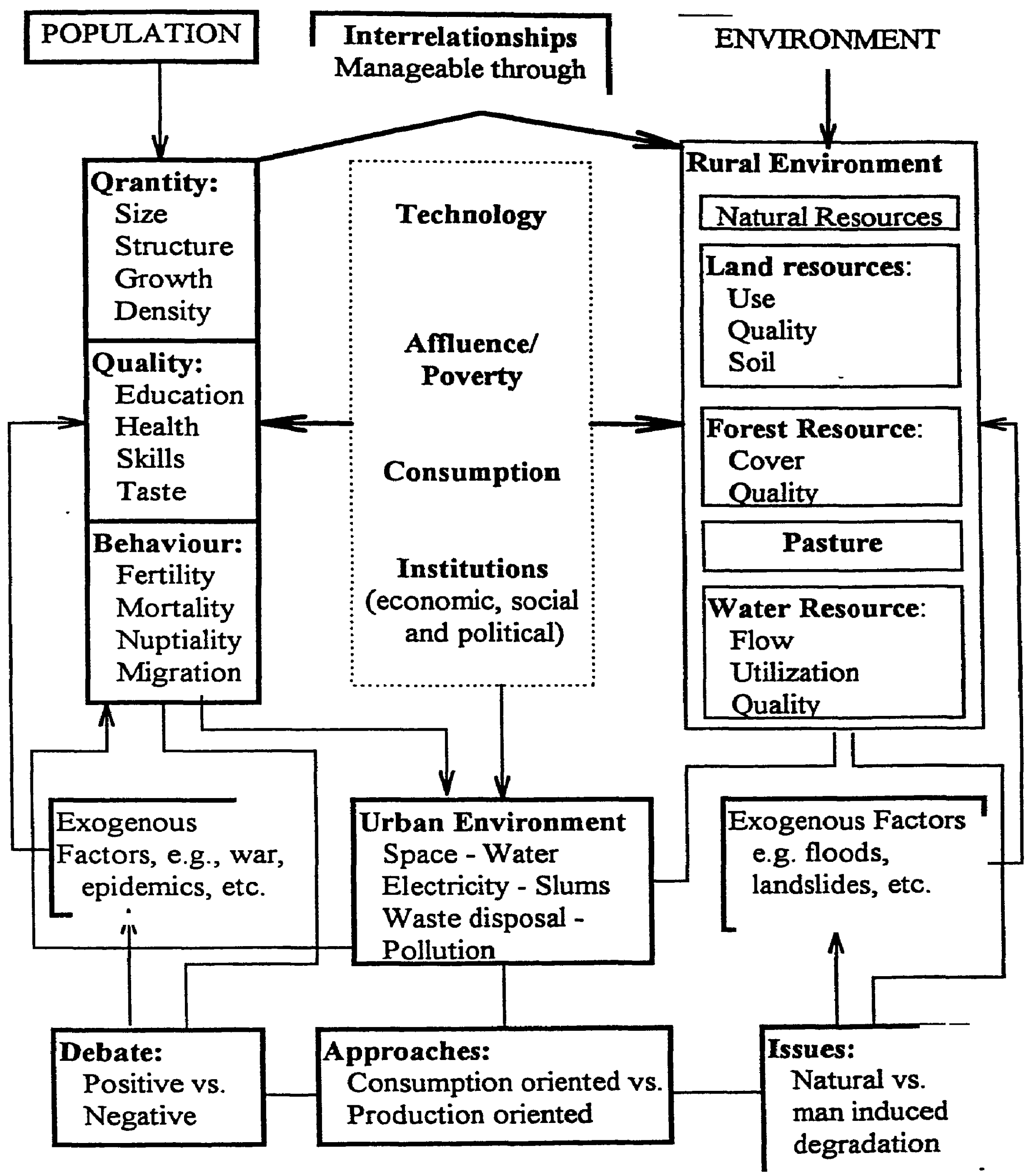
where **I** is a measure of environmental impact, **P** stands for an index of population, **A** is per capita consumption, and **T** is a measure of environmental damage done by technology used in supplying each unit of consumption.

Dimensions of Complexity

Figure 1 attempts to summarize the interrelationships between population and environment. The left panel shows population and its various dimensions whereas the right panel shows selected dimensions of environment. The issue of population is not only related

Figure 1

Population and Environment Relationships: A Schematic Digram



Source: Subedi, 1995.

to its quantity i.e., size, structure, growth, and distribution, but also with the quality. The indicators of quality of population include level of education, health, technical skills and tastes (values) some of which citizens may have developed through their culture. In addition, the behavioral aspect of population including fertility, mortality, nuptiality and migration have direct ramification on the utilization of environment.

Likewise, environment in general is translated as the natural resource base. In the context of developing countries such as Nepal the most commonly used environmental resources include land, forest, water, and pasture and that their quality, coverage and level of utilization are equally important as that of their magnitude. The middle panel specifies the critical variables from which the impact and the mutually reinforcing relationship between population and environment materializes. This signifies that the use/misuse, utilization and assessment of carrying capacity is manifested through existing technology, affluence/poverty, consumption level and efficiency (or misconduct) of existing social, economic and political institutions.

The lower middle panel specifies the attributes of urban environment. Commonly observed urban environmental issues in the countries such as Nepal include space, slums/squatters, water supply, electricity, waste disposal, and various kinds of pollution. Whereas the quality of urban environment is influenced by the intermediate variables of the middle panel i.e., technology, consumption, affluence, and institutions, this (urban environment) is also a manifestation of size and distribution pattern of population of the country. The level of urbanization, in turn, help modify fertility behavior and social quality of population. Whereas the interrelationship between population and environment is interactive, it is also dynamic and that any change in the components of each of these variables will have corresponding impact on the other variables. Similarly, an introduction of a new technology, a change in consumption level and institutional commitment will bring significant changes in the existing relationships between population and environment.

Further complexity arises when exogenous factors enter into this realm. Disease epidemics, wars, and political turmoil bring instability in the existing structure of population component, thereby the nature of relationship with the environment. Likewise, natural disasters such as flood, landslides, earthquakes, and volcanoes function as the exogenous factors for environmental component. These exogenous impacts severely constrain the existing status of environmental resource base and in turn limit its carrying capacity of population. This upsets the existing population-environment relationships and thus inhabitants are compelled to readjust as well as react.

There are various unsettled issues, approaches and debates in the literature about population, its behavior and the nature of environmental problems. Scholars such as Simon (1981) argue that because people are the ultimate resource, there is little or no reason to be pessimistic about population growth. Similarly, scholars working through production-oriented approach take the view that population growth is not necessarily a bad idea (Boserup, 1968) simply because the new generation also brings talent and earning hands with them.

On the other hand, there are those who are not very optimistic about the growth and its impact in the world. They consider population growth as a problem taking into account of changes occurring in the world food situation over the years. Accordingly, they argue that food situation has reached a precarious state and in the long run substantial further growth is considered simply unsustainable (see, Bongaarts, 1993; Ehrlich and Ehrlich, 1990).

Based on Malthusian perspective some scholars take consumption oriented approach to population and warn that any additional number is burdensome on the humanitarian ground. Furthermore, the issue of who is to blame takes us to the ideological and methodological debate which is beyond the scope of this paper. In the study of human-environment interrelations concerns about whether humans are the sole agents of environmental degradation and if not, how much of degradation can be directly attributed to human action and how much of it to the action of the natural processes are very difficult issues to deal with. This is more so in the context of developing countries characterized by stagnant economy, rapid population growth and whose physical landscape is dominated by fragile mountains of recent origin.

The Case of Nepal

Nepal is an interesting case where population has grown very rapidly over the last few decades and where environmental degradation has been severe. It is a small country with an area of 147,181 sq.km. and is characterized by three distinct physiographic divisions namely, the Mountain, the Hills and the Tarai (plain). While the Hills were settled from historical times by people coming from north as well as south (Poffenberger, 1980; Subedi 1988), settlement in the Tarai is mostly a phenomenon of the last few decades. Frontier settlement and Colonization in Tarai (Conway and Shrestha, 1981) is also one expression of population growth within and outside the Tarai regions as well as in the states of the adjoining country.

Because ninety percent of Nepal's people live in rural areas and agriculture is their main life-way, people have constantly looked for additional land for expansion of agricultural areas to support the expanding population as well as to improve their economy. In this process, people have put heavy pressure on the local environment and thus, local environment has suffered. As early as in the 1970s statements such as "Nepal faces the world's most acute national soil erosion problem" (Eckholm 1976:77) and "the continuation of present trends [of deforestation] may lead to the development of a semi-desert type ecology in the hilly regions" (Ibid:81) were made. These are rather extreme statements. However, they reflect the seriousness of the problem. In this context, the following sections provide glimpse of growth of population and its impact on environment in general and the Tarai in particular.

Growth of Population

For most part of history, the population size of Nepal was small and the growth was slow. The earliest figure available is for 1911 which shows a population size of 5.6 million. The following two decades record a decline in the size of population in the country. This apparent decline has been attributed to the World War casualties and under reporting especially of adult males for the fear of conscription into the armies. The figure in 1941, for the first time, shows an increase in the total volume. It is to be noted that figures up to 1941 are rather estimates and details on age, sex and other characteristics were not reported.

Over the last few decades the population of Nepal has grown more rapidly than ever before. The first "scientific" census i.e., 1952/54, recorded a total population of 8.26 million in the country with annual growth rate of 2.3 percent. The successive censuses have recorded continuous increase in the size of population in the country (Table 1). The actual size has more than doubled between 1952/54 and 1991.

Table 1. Nepal: Growth of Population

	Total Population	Annual Growth rate	Approx. Doubling Time
1911	5,638,749	N.A.	-
1920	5,573,788	- 0.13	-
1930	5,532,574	- 0.07	-
1941	6,283,649	1.16	60
1952/54	8,256,625	2.30	31
1961	9,412,996	1.65	42
1971	11,555,983	2.07	34
1981	15,022,839	2.66	26
1991	18,491,097	2.10	33

Source: CBS 1987, 1993.

Growth rates have remained consistently over 2.0 percent per annum (except 1961 census) during these decades. The most recent census i.e., 1991, enumerated a total of 18,491,097 person in the country with the intercensal growth rate of 2.1 percent. This means that if this growth rate continues there will be another "Nepal" before 2024.

Moreover, the official estimate suggests that the population has already reached 21.13 million by 1996 (CBS, 1994).

Regional Disparity

Rapid growth in size and rate of growth in the nation's population in general is an important issue. More important in the context of Nepal is the disparity in growth by geographical regions. Change occurred over successive periods in the proportional share of total population and density differential by geographical regions clearly shows this. Of the three geographical regions the Hills had majority in 1971. This was followed by the Tarai and the gap between the Hills and the Tarai was very wide (Table 2). By 1981 the gap has been narrowed significantly but the Hills still dominated. By 1991, for the first time in the history, the Tarai emerged as the region with highest percent of the nation's population. The Hills trailed behind with 45.5 percent. The share of the Mountain has continuously declined from 9.9 percent in 1971 to only 7.8 percent by 1991.

Table 2. Nepal: Changing Regional Proportion and Density of Population (1971-1991)

Geographical Regions	Percentage of total population			Density of population (/km^2)		
	1971	1981	1991	1971	1981	1991
Mountain	9.9	8.1	7.8	22	25	28
Hills	52.5	47.7	45.5	99	117	137
Tarai	37.9	43.7	46.7	129	193	254
NEPAL	100	100	100	79	102	126

Source: Population Census 1971, 1981, and 1991.

While the regional proportion has changed over the last three decades, more pronounced change has occurred in the regional man-land ratios. The crude density has increased for the country as well as for all the geographical regions between 1971 and 1991. The extent of increase is more pronounced in the Tarai than in the Hills and the Mountains (Table 2). Between 1971 and 1991 the crude density in Tarai has increased by 97 percent i.e., from 129 persons per square kilometer in 1971 to 254 persons per square kilometer in 1991. Corresponding changes in the Hills and the Mountains during the same period has occurred by only 38.4 and 27.3 percent respectively. This indicates that the impact of population growth is most visible in the Tarai than any other regions of the country.

The distribution of both the total and cultivated land is uneven. The Hills occupy major proportion of total land and is followed by the Mountains. There is a clear regional difference in the proportion of cultivated land, the relative stress of population and consequent physiological density. Tarai which occupies 23 percent of total area accounts for 56 percent of the country's cultivated area. As a result, its physiological density is the lowest in the country despite the fact that it ranks highest in the crude density. The Hills which support 45.5 percent of population occupy only 37 percent of cultivated land. Accordingly, the physiological density is 960 persons per hectare in the Hills, i.e., the highest in the nation. The Mountain region ranks second with 890 persons per hectare and occupies only 7 percent of cultivated land. It is interesting to note that even though the arithmetic density in the Tarai has increased by 97 percent over the last 20 years, it's physiological density per hectare is still less by 300 persons than that of the Hills (Table 3).

Table 3: Nepal: Regional Disparity in Land and Related Ratios

Regions	Total Area		Cultivated Area		Ratios (density)	
	Area (in km^2)	Percent	Area (in hectare)	Percent	Nutritional (P/ha)	Cultivated area per capita (ha)
Mountain	51817	35.2	163,093	6.9	890	0.113
Hills	61345	41.7	878,837	37.4	960	0.105
Mt/Hills	113162	76.9	1,041,930	44.3	950	0.106
Tarai	34019	23.1	1,311,785	55.7	660	0.152
NEPAL	147181	100	2,353,715	100	790	0.127

Source: CBS 1987, 1993, 1994.

Reliable longitudinal data on cultivated land are not available. Recent Agriculture Sample Census of Nepal, 1991 demonstrates that average per capita cultivated land is 0.127 hectare. Both the Hills and the Mountain region have per capita cultivated land below the national average. Only the Tarai region has this value above the national average (Table 3). A study estimates that under the current production system a farmer needs 0.15 hectare of land to meet average calorie intake (Pant, 1992). If this amount is to be applied to the current distribution of population with an assumption of land being the main source of calorie intake, the deficit comes out to be 420 thousand hectares for the nation. While the Hills appear to have a deficit of 383 thousand hectares, the corresponding deficit in the Mountain happens to be 53 thousand hectares. On the contrary, the Tarai will have some surplus of 16 thousand hectares. This arithmetic of surplus and deficit further supported by malaria eradication program and resettlement scheme of 1950s in the Tarai apparently lies at the heart of escalating Hill to Tarai migration in the country.

Internal Migration

One of the responses of the apparent demographic change is internal migration. The last four censuses have shown an increasing trend of life-time internal migration. The Hills and the Mountains have remained the main place of origin for more than 90 percent of the population. Likewise, the Tarai has become the major destination for majority of migrants. Between 1981 and 1991, the overall regional pattern of migration has remained consistent although the some changes have occurred in the proportionate share of each of the regions over the two censuses. The Tarai has continued to be the main receiving area and its proportion has increased over time (Table 4). On the contrary, the share of both the Hills and Mountains has further decreased with respect to receiving internal migrants.

Table 4. Nepal: Percentage of Life-time Internal Migrants (1981 and 1991)

Geographical Regions	In-migrants (in percent)		Out-migrants (in percent)	
	1991	1981	1991	1981
Mountain	02.8	05.2	14.2	30.3
Hills	18.8	20.4	72.0	61.3
Tarai	78.4	77.4	13.8	08.4
NEPAL	100.0 (1,418,206)	100.0 (1,038,862)	100.0 (1,418,206)	100.0 (1,038,862)

Note: The figure in the parenthesis indicate the volume of internal migration.
Source: Population Census 1981, 1991.

Of the total population, 6.9 percent comprised of internal migrants in 1981 while this proportion increased to 7.7 percent in 1991. Of the total migrants in 1981, 61 percent originated from the Hills and 30 percent from the Mountains. The share of the Tarai has been the least. By 1991, the Hills have become the place of origin for 72 percent of internal migrants (Table 4). While the proportion of the Mountains has decreased from 30 percent to 14 percent, the proportion of the Tarai has significantly increased in 1991. This suggests that the Hills have experienced the highest net loss and that the Tarai is characterized by a net gain.

Of the total employed among 10 years of age and over, 81 percent are in agriculture according to 1991 census. The corresponding percent for 1981 was 91 percent. Being an agricultural country, the stream of migration is directed mainly from rural to rural areas. Rural- urban migration has become an emerging issue (see, Sharma, 1989; 1993; Subedi, 1988) but its volume is still very low. The fact that per capita cultivated land is lowest in the Hills and is grossly inadequate to maintain household economy, clearly demonstrates the increasing flow of Hill to Tarai migration. In addition, according to 1991 census, about 40

percent of economically active population worked for less than eight months in 1990. This is indicative of underemployment and thus, the search for better opportunities is imperative. One of the consequences of this whole process of population growth and migration is land use change and deforestation in general and in the Tarai in particular.

Land Use Changes

At present, major productive land use categories in Nepal include forest, agriculture, and pasture. Forests including shrubs occupies the highest proportion and is followed by agriculture land (Table 5). A large proportion of land surface is occupied by rocky land. Rocky surface including snow capped areas occupy approximately one-sixth of the national territory. Land used for pasture comprises 11.8 percent of the land but most of it is of low quality.

Table 5. Nepal: Land Use Pattern, 1986

Types of Land Use	Total Area (in hectare)	Percentage
Agriculture	3,954,915	26.6
Cultivated	2,968,017	20.0
Uncultivated	986,898	6.6
Forest	6,306,460	42.4
Forest land	5,618,052	37.8
Shrubs	688,408	4.6
Pastures	1,757,345	11.8
Rocky surface	1,966092	13.2
Others	870,230	6.0
Snow Area	506,317	3.4
Stone/Sand		2.3
Steep Terrain	322,428	0.0
Barren Land	5,575	0.1
Lake/Pond	13,414	0.1
Urban Area	11,584	0.1
	109,14	
TOTAL	14,855,042	100.0

Source: NPC, 1992.

Availability of comparable data is the main problem to asses the extent of change taken place over the recent years because different sources present different data on the total land use pattern. In any case, with the growth of population, significant changes in land use have taken place over the years. The most notable change has taken place in agriculture, pasture land, and forest. Sixth Plan (1980-1985) reports that in 1974 the total land under agriculture was 16.5 percent. The same document also reports that in 1979 the total land under agriculture reached 22.2 percent, an increase by 5.7 percent. Similarly, according to the Eighth Plan (1992-1997), total agriculture land accounts for 26.5 percent of the total area of the country. This is indicative of significant change in bringing other land uses under agriculture. Increase in total agriculture land cannot be considered either positive or negative in itself. However, the fact that some of the recent increases in agriculture land are slope and marginal lands which are less productive plus environmentally sensitive means that the direction of change is incongruous to keep a better harmony between environment and population.

Change in area under agriculture is reflective of population growth and their ever increasing needs. Average land holding of about fifty percent of the household with an average family size of 5.5 persons is less than 0.5 hectare and hence not sufficient to meet their basic requirements (Pant, 1992). There is, thus, a strong demand of additional land for agriculture. Whereas bringing other land uses under cultivation has remained the main coping strategy with population growth thus far, the future prospect of land expansion for agriculture is minimal primarily in the Hills and Mountains. Reports suggest that it has already reached limits (Banskota, 1992). It is to be noted that even the better lands in Tarai, the only frontier left, has been brought under cultivation. This insinuates too negative a picture and this is not the whole story. Some positive changes such as inter-cropping, multiple cropping, intensification, and an increase in cropping intensity, have also taken place (to be discussed later).

Whereas agriculture land has increased, the proportional share of pasture land has decreased. A cursory examination of government's plan documents clearly justifies this. Of the total land resource 12.7 percent was used as pasture land in 1974. Data for 1979 report that same proportion of total land resource was devoted for pasture land. A decline in the total percentage of pasture land is evident after 1979. By the Eighth Plan the total pasture land comprised of only 11.8 percent of the total land of the country showing a decline by 0.9 percent (Table 5). This decrease is primarily attributed to its conversion into agriculture land over the years.

Structurally, the landscape of the country is composed of young mountains. Thus, the terrain is naturally fragile, erodible and inaccessible. More importantly, human factors have further accelerated this process and a report indicated that approximately 53 percent of landslides in Nepal were man-made (NPC, 1985). Human misuse such as cultivation in slopes greater than 30 degrees, and terracing without proper drainage consideration has further accelerated the process of erosion and landslide and have collectively made the land use and utilization pattern dynamic.

Deforestation

In a traditional society where agriculture is rather a way of life, population growth has consecutively accompanied increased demands for agriculture land, fuel-wood, and pasture. All of these have singly as well as collectively resulted into deforestation and degradation of forest. This process has accelerated more after the 1950s mainly for three reasons: a) the rate of population growth became rapid, b) the initiation of resettlement program following the malaria eradication program functioned as the opening up of the flood gate, and c) forests traditionally managed by community were nationalized in 1957. Nationalization was done amidst the weak managerial capacity of the government. This was collectively the beginning of the tragic course of action on forest land and ultimately led to the process which is, to use Hardin's (1968) metaphor, "the tragedy of the commons." Locked with poverty and growing number, individual households rushed to exploit forest for agriculture land, fodder, pasture and fuel-wood. In the process, societal goals of conservation and environmental management were pushed to the periphery.

Available data are often in conflict about the direction of change in areas under forest. Sixth Plan (1980-1985) recorded 29.1 percent of the total land of the country as forest land while the eighth plan documented it to be 42.2 percent (Table 5). Earlier studies have reported heavy deforestation in the Tarai during 1960s and 1970s and that this process has not stopped even though the extent has decreased. From 1950 to 1985, 103,968 hectares of forest land was cleared for settlements (see, Bhatta, 1992). Master Plan for Forestry Sector (FSMP) estimated that the average annual loss of forest area from 1978/79 to 1984/85 was 7,566 ha. or 0.14 percent of the natural forest (HMG/ADB/FINNIDA,1988). On the other hand, effective reforestation was hardly 8.7 percent of the reduced forest area (Bhatta, 1992).

Degradation and change in crown cover of forest is an important aspect of Nepalese natural landscape and that such a degradation is more serious in the Hills. FSMP (1988) demonstrates that from 1979 to 1985, approximately 219,300 ha of forest land was degraded due to over cutting to meet the increasing demands of people and livestock. As of 1985/86, the crown cover is less than 70 percent for more than 80 percent of the forests and only 15 percent of the total forests have crown cover of 70- 100 percent (Mishra, 1994) LRMP (1986) reported that between 1964 and 1985 area under forest cover was reduced by 22,800 ha. per year (LRMP, 1986) and The loss of forest land is normally attributed to conversion into cultivated land, cutting for fodder and fuel wood (Bajracharya, 1983), and occasional fire by the herders.

Deforestation in the Tarai

The 1960s and early 1970s were mainly characterized by heavy forest clearance especially in the Tarai areas. During the period 1964-74, a total of 77,700 hectare of forest land was cleared for the official settlement and during the same period an additional amount of 237,600 hectare was encroached by spontaneous settlement (NPC, 1975). The depletion

of forest was estimated at the rate of 3.9 percent per annum up to the end of 1980s (FRSC, 1993). Compared with the Tarai, less forest land has been lost in the Hills primarily for two reasons: a) the scattered nature of the forest there, and b) lower productivity of land underneath the forests. Nonetheless, degradation of forest resources is still severe in areas in the Hills where man-land ratio is very high. Expansion of land for cultivation has been the main reason so far, for the depletion of forest. A report suggested that during the period 1975-80 forest area declined by 700 thousand hectares while cultivated land increased by more than 800 thousand hectares during the same period (NCP, 1982).

Forest clearing is difficult to avoid given the increasing population in the adjoining Hills and lack of income generating opportunities there. With the opening up of infrastructure in the previously inaccessible areas in the Tarai, the inflow of population from the resource poor Hills and Mountain areas became imperative there. Recent changes in the forest area between 1978/79 and 1990/91 is further justifies the impact of population growth on its environment. Of the three regions, Tarai is the area where most of the deforestation has been taking place and that these deforested areas continue to be converted into agricultural land. Up until recently the extent of forest depletion increased gradually from west to east (Gurung 1989). This in turn also reflected the regional concentration and higher rate of population growth in the east than that of the west. More recently this trend has changed and the extent of deforestation has been more pronounced in the western regions than the eastern ones (Table 6) and that population has increased rapidly in these areas as well in recent years (Table 7).

According to the recent available data forest covers 37 percent of the total land in the country. The Forest Survey Division of the Forest Research and Survey Division has recently estimated the forest resources of the 20 Tarai districts. Accordingly, the total forest area in the Tarai is 1.4 million hectares. Of the total, 546 thousand hectares (38.84 percent) lies in the plains and 621.5 thousand hectares (44.22 percent) in the hills. The remaining hectares are included in the conservation area. Between 1978/79 and 1990/91, a total of 99,400 hectares of forest land has been lost in the plains of Tarai. This means that the forest area in the plains of Tarai has reduced from 645.3 thousand hectares in 1978/79 to 545.9 hectares in 1990/91 (Table 6). In the plains the most recent rate of deforestation is estimated at 1.3 percent (APROSC/JMA, 1995). This is an improvement over the Master Plan for Forestry Sector of Nepal which estimated the deforestation rate of 3.9 percent between 1978/79 and 1985/86.

Table 6. Nepal: Change in Forest Area in the Plains of Tarai districts (1978/79 - 1990/91)

Name of the District	Forest Area in the Plains (in hectare)		
	1978/79	1990/91	Percent Change
Jhapa	19100	15000	- 21.5
Morang	31900	26700	- 16.3
Sunsari	14800	11100	- 2.5
Saptari	5100	3300	- 35.3
Siraha	4100	4300	+ 4.9
Eastern Tarai	**75,000**	**60,400**	**- 19.5**
Dhanusha	2000	2600	+ 30.0
Mahottari	12800	9400	- 26.6
Sarlahi	15700	13500	- 14.0
Rautahat	25400	24100	- 5.1
Bara	38200	35400	- 7.3
Parsa	25700	23200	- 9.7
Chitawan	20900	18500	- 11.5
Central Tarai	**140,700**	**126,700**	**- 10.0**
Nawalparasi	33900	25600	- 24 5
Rupandehi	25600	16000	- 37 5
Kapilvastu	54300	46600	- 14.2
Western Tarai	**113,800**	**88,200**	**- 22.5**
Dang	38000	36400	- 4.2
Banke	72800	63100	- 13 3
Bardiya	44100	38700	- 12.2
Mid-western Tarai	**154,900**	**138,200**	**- 10.8**
Kailali	109900	93800	- 14.7
Kanchanpur	51000	38600	- 24.3
Far-western Tarai	**160,900**	**132,400**	**- 17.7**
Total	645,300 00	545,900 00	- 15.4

Source. Forestry Survey Division, Forest Research and Survey Center, Ministry of Forest and Soil Conservation, 1993.

Degradation of existing forest is also an equally important issue in Tarai. Apart from cutting forest for agriculture, a large amount of trees have been cut annualy for fuel-wood because firewood is the major source of energy. According to a report, almost 80 percent of energy consumed domestically came from fuel-wood in 1992/93 (WECS, 1992/93). An

earlier publication indicated that due to increased energy demand forests around the village have been cut and thus fetching the fire-wood has become a task of half a day or more of a walk to reach the forest for firewood (Banister and Thapa, 1981). This has not changed much in the 1980s and 1990s. The increase in population has continued. While it was more pronounced in the eastern tarai earlier, western regions have picked up lately. Annual growth rate of population for Mid-western and Far-western Tarai exemplify this (Table 7).

Table 7: Intercensal Change in Population in Tarai Districts (1971-1991)

Name of the District	Population in 1971	Growth Rate (1971-81)	Population in 1981	Growth Rate (1981-91)	Population in 1991	Growth Rate (1971-91)
Jhapa	229,561	7.37	479,743	2.13	593,737	4.8
Morang	293,639	5.99	534,692	2.33	674,823	4.2
Sunsari	238,312	3.69	344,594	2.96	463,481	3.4
Saptari	292,108	2.61	379,055	2.06	465,668	2.4
Siraha	302,212	2.17	375,358	2.05	460,746	2.1
ETR	**1,355,832**	**4.44**	**2,113,442**	**2.30**	**2,658,455**	**3.4**
Dhanusha	330,501	2.69	432,569	2.29	543,672	2.5
Mahottari	298,346	1.91	361,054	1.98	440,146	1.9
Sarlahi	265,634	4.06	398,766	2.12	492,798	3.1
Rautahat	256,238	2.61	332,526	2.19	414,005	2.4
Bara	233,330	3.13	318,957	2.65	415,718	2.9
Parsa	202,062	3.42	284,338	2.70	372,524	3.1
Chitawan	183,588	3.46	259,571	3.12	354,488	3.3
CTR	**1,769,699**	**3.00**	**2,387,781**	**2.39**	**3,033,351**	**2.7**
Nawalparasi	183,973	5.18	308,828	3.45	436,217	4.3
Rupandehi	243,272	4.44	379,096	3.20	522,150	3.8
Kapilvastu	205,154	2.75	270,045	3.20	371,778	3.0
WTR	**632,399**	**4.15**	**957,969**	**3.28**	**1,330,145**	**3.7**
Dang	186,507	3.57	266,393	2.85	354,413	3.2
Banke	130,476	4.53	205,323	3.30	285,604	3.9
Bardiya	102,741	6.61	199,044	3.77	290,313	5.2
MWTR	**419,724**	**4.69**	**670,760**	**3.27**	**930,330**	**4.0**
Kailali	135,982	6.40	257,905	4.83	417,891	5.6
Kanchanpur	68,842	8.98	168,971	4.23	257,906	6.6
FWTR	**204,824**	**7.34**	**426,876**	**4.60**	**675,797**	**6.0**
TOTAL	4,382,478	4.03	6,556,828	2.75	8,628,078	3.4

Source: Population Census 1971, 1981, and 1991.

Crop Production and Cropping Intensity

With the growth of population, important changes in crop production and cropping intensity has taken place in the last two decades. These positive changes have been overlooked in the face of environmental crisis viewpoint. Likewise, contrary to what has been advocated by the extreme environmentalists not only areas cultivated for the food grains have increased production of food grains has increased at rates higher than the rate of population growth (Table 8). The production of cereal crops has increased by more than 52 percent between 1981 and 1991. The Hills have the most increase in production in both the amount as well as percent change. The increase in terms of percent change is followed by the Mountain. Tarai has the lowest increase. This increase parallels with the physiological density of the regions where regions with highest physiological density i.e., the Hills, has the highest increase. Similar increases have taken place in the production of cash crops as well. In terms of productivity however, there are mixed outcomes. Reports suggest that while productivity of some crops has declined it has increased or remained stable for others (see, Acharya, 1993, Banskota, 1992).

Table 8: Growth in Cereal and Cash Crop Production

Ecological Regions	Cereal Crop Production (in 000 mt)			Cash Crop Production (in 000 mt)		
	1981	1991	Percent Change	1981	1991	Percent Change
Mountain	155.1	255.2	64.5	68.8	151.1	119.6
Hills	1152.8	2174.9	88.7	201.4	430.5	113.8
Tarai	2521.1	3398.4	34.8	572.8	1361.4	137.7
NEPAL	3829.0	5828.5	52.2	843.0	1943.1	130.5

Source:CBS, 1985; DFAMS/Nepal, 1992.

Population growth and production increase are also accompanied by increase in cropping intensity. Between 1981 and 1991, cropping intensity has increased for 80 percent of the Tarai districts (Table 9). More importantly, this increase is remarkable in Jhapa, Dhanusha, Chitawan and Morang districts. Except Dhanusha, these are also the districts whose population growth rate has been consistently higher than the average for the Tarai. Of all the districts Chitawan has the highest cropping intensity and this is also the area where first resettlement scheme for the Tarai was launched in the 1950s.

This increase in production of both the cash and cereal crops in excess of population growth rate and increase in the cropping intensity can be taken as positive aspects of population growth. This is in the context of traditional form of agriculture with low level of agricultural inputs and limited irrigation facilities.

Table 9. Nepal: Cropping Intensity in the Tarai Districts (1981 and 1991)

Name of the District	Cropping Intensity		
	1981	1991	Percent Change
Jhapa	1.16	1.65	42.2
Morang	1.55	1.89	21.9
Sunsari	1.61	1.73	7.5
Saptari	1.49	1.59	6.7
Siraha	1.63	1.85	13.5
Dhanusha	1.24	1.71	37.9
Mahottari	1.71	1.85	8.2
Sarlahi	2.00	1.90	-5.0
Rautahat	1.80	1.96	8.9
Bara	1.71	1.81	5.9
Parsa	1.88	1.77	-5.9
Chitawan	1.80	2.21	22.8
Nawalparasi	1.64	1.66	1.2
Rupandehi	1.75	1.66	-5.1
Kapilvastu	1.39	1.55	11.5
Dang	1.91	1.85	3.1
Banke	1.60	1.48	-7.5
Bardiya	1.60	1.81	13.1
Kailali	1.92	1.87	-2.6
Kanchanpur	1,60	1.90	18.8

Source: National Sample Census of Agriculture, 1991/92.

Conclusion

The population-environment relationship is complex and mutually reinforcing. In the context of Nepal attempt to examine the overall impact of population growth on its environment is at best indicative of the trend because of the data problem. Longitudinal data are not available especially on the issues of environment and even the available cross-sectional data are inconsistent and different sources present different and often conflicting data. Moreover, the tendency of dealing with population and environment in isolation for lang has resulted into poor understanding of imperatives of population growth and mountain specificities (Banskota and Joddha, 1992) in which Nepalese people make decision on the use of their environment.

With the growth of population whose livelihood is primarily based on the traditional form of agriculture, significant environmental changes have taken place in Nepal over the last few decades. Changes in land use in general and forest cover in the Tarai in particular are clear examples of this. Changes taken place have both negative and positive impacts. While the negative changes are well verbalized, increase in crop production and cropping intensity at the rate much greater than the population growth are positive indications. The interpretation of environmental changes must be based on the correct assessment (Shrestha, 1993), in the context of in-built geomorphic processes, the imperatives imposed by fragility of the mountains and long-standing copping strategy (see, Subedi, 1995) of the mountain people.

Several mico-level studies have also reported positive aspects of change such as better management of land in Khumbu areas and soil erosion not as bad as has been reported (Byers, 1986), efficient management of pasture (Shrestha and Manandhar, 1977); deforestation and depletion of forest not intense in the middle Hills (Mahat, 1986), occupational multiplicity in eastern Nepal (Subedi, 1993), and innovative responses to population pressure in eastern Hills (Dahal 1983). The rate of forest depletion at the regional level has improved to 1.3 percent (FSRC, 1993) from 3.9 percent estimated earlier (HMG/ADB, 1988). It is important that evidences from micro-level studies need to be linked with the macro-level generalized studies in order to better understand the interrelationships between population and environment in Nepal.

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Population dynamics, environment, and conflict

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Population dynamics, environment, and conflict

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1. Introduction

In the history of Western thought, [people] have persistently asked three questions concerning the habitable earth and their relationship to it. Is the earth, which is obviously a fit environment for [human] and other organic life, a purposefully made creation? Have its climates, its relief, the configuration of continents influenced the moral and social nature of individuals, and have they had an influence in molding the character and nature of human culture? In his long tenure of the earth, in what manner has man changed it from its hypothetical pristine condition?

Glacken (1967), quoted in Goudie (1993, 1).
[people] and [human] substituted [men] and [man] in text.

Glacken's second and third questions have not been fully answered. Indeed the Genesis notion which set humas above and against nature, entitled to rule like absolute despots, was "formulated into a philosophy of science and progress by men like Baccon, Galileo and Descrates." (Goudie 1993, p. 2). In their conscience or unconscience attempts to change their environment, human values and cultures are being equally changed. The chain of change--from people's prevailing values, technology and institutions, to changing environment, leading to change in values, technology and institutions--creates pressures and unequal opportunities, leading to potential conflict among and within human societies, and between people and their environment. One of the important forces, in this chain of change, that lead to potential conflict is that of population dynamics. How does population change lead to environmental change and potential conflict is the focus of the present paper.

Population dynamics is a discipline that deals with the determinants and consequences of changes in the structure, growth and distribution of populations over time. By structure, we mean the distribution of a given population by age and gender. There are two concepts of population growth. The first relates to total change in population relative to a base population size. Total change includes the balance of births, deaths and net international migration in a given period of time and within a given national boundary (conventionally called the rate of population growth). The second is defined as the natural rate of population growth. This natural rate of population growth focuses on differences in the vital rates of births and deaths, and excludes migration as a source of increase or decrease in population

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size. Indeed, in the case of a "closed population," the two rates are equal. Distribution refers to the spatial distribution of a population within a national boundary, such as rural-urban or regional balance within a country. It also relates to measures of density. As will be evident from the following discussion, population growth, structure and distribution constitute a consistent and interrelated demographic sub-system of society. They are also an integral part of the larger social, economic and environmental system.

The purpose of the present paper is to investigate the role of these basic demographic phenomena as a source of social and political conflict or disorder. Harmony and order are not the norm in a world of continuous and accelerating changes in technological and environmental conditions. Many of these changes are not confined to their areas of origin. Furthermore, not all changes are predictable. Many could be sudden, radical and uncertain. Recent developments in multi-media and information technology are examples of rapid technological changes with many unexpected and as yet unforeseen world wide socio-economic, legal and political ramifications. Uncertainty is illustrated by changes in environmental conditions that were thought to be relatively stable and predictable as indicated by the case of the Greenland ice cores. Systematic observations of these cores questioned the conventional view of the stability of climatic conditions over long periods of time. Considering such observations, J. Piel concluded that 'climate can change suddenly and radically' (Piel, .1993, p. 16). Will we have time to adapt to such unforeseen environmental and technological changes, especially where many of the consequences seem to have no respect for national boundaries? What is the role of population change, as a cause and effect, in this era of uncertain change? More specifically, are there patterns of population change that reduce the adaptive capacity of the system to deal with conflict? These are the questions that lie at the core of the present discussion.

By the adaptive capacity of the system, we mean the extent of society's technical and social sustainability. Technical sustainability implies the ability of society to maintain over time the productive capacity of its core resource endowment. Social sustainability implies the harmonious evolution of its social contracts and of the *institutions* necessary for the enforcement of these contracts, within and across generations, in the face of such changes. The dichotomy of the adaptive capacity of the social system into technical and social spheres parallels that of the material and ideational antecedents of institutions. As McNicoll put it:

> "Institutions .. emerge or are designed as ways for people to deal with recurrent problems about material realities (resources, technologies, environmental conditions, human biology) and as manifestation of ideational systems that give some degree of coherence in the cultural domain of symbol and belief. (McNicoll, 1994. p. 6).

The main argument of McNicoll (1994, p.7) is that institutions are path-dependent. They are:

> "A precipitate of time. They adjust (admittedly with some delay, and at times only, so to speak, with considerable provocation) to changing circumstances-- say, shifting power relations among social groups or altered transaction costs. But the direction in which they adjust depends not merely on those new circumstances but also, and crucially, on their past history."

From the perspective of the present discussion, the adaptive capacity of society, especially as it relates to conflict, is a function of the mechanism by which institutions evolve. The question as to how institutions evolve is yet unsettled. The recent research program in sociology (e.g., Michael 1983), which attempts to illustrate that institutions emerge from behavior, seems to be, on the one hand, an attempt to indicate the universality of a standard explanation or theory to all institutional settings, and an overly optimistic program, on the other hand. The parallel in economics is the attempt to impose the atomistic Newtonian paradigm of the equilibrium of forces, with possible growth but no genuine qualitative change in society, as the universal explanation of social and economic evolution. It could be argued that the atomistic Newtonian paradigm, as a philosophy, has its origin in pre-Socratic Greek philosophy, in particular that of Anaximander. Anaximander believed in the existence of an equilibrium of forces whose final outcome is an optimal state of justice; however, his system is not fully deterministic. He allows for uncertainty in his evolutionary paradigm:

> "Anixmander offers an underlying metaphysical principle that explains the surface appearance of things. For the implication may be that the changes and conflicts, the give and take that we observe occurring every where in nature, are parts of a process of *exploration and reparation* that, in the long run, maintains an equilibrium or a state of '*justice*' in the whole" (Collinson, 1990, pp. 5-6, emphasis added).

In the atomistic Newtonian paradigm, social structures are incidental. They are merely the children of a system of micro-behavior that is always consistent, optimal and independent of time. Recent literature on the behavior of government as a social and political institution, which represents collective behavior, is illustrative of the incidental nature of structures in this paradigm. In that 'positive' framework, the evolution of government is a result of agents' maximizing behavior, i.e., to maximize their length of stay in power or their budget, subject to existing resource and power constraints. These constraints, mainly exogenous, are set by the existing distribution of wealth and political power. Indeed, under special and rather strict conditions of perfect competition in the economic, social and political domains, the two types of welfare maxima, atomistic and collective, may coincide; however, the world is imperfect. The causes of the imperfection are outside the paradigm. Understanding the sources of the constraints, whether economic, social or political, is the study of the structure of institutions. In the absence of such analyses, development is reduced to *atomistic* behavior on the margin.

The limitation of the atomistic paradigm has been discussed extensively in the literature (e.g., McFarland 1991). Many economists have been wary of the indiscriminate application of standard theory to development economics. This is best illustrated by Georgescu-Roegen (1971), who warned against the universal application of the Newton-Smith equilibrium paradigm without regard to contextual differences, especially to the case of developing countries:

> "For the tenacity with which we cling to the tenet that standard theory is valid in all institutional settings--either because its principles are universally valid or because all economic systems are mixtures of some invariable elements--has far-reaching consequences for the world's efforts to develop the economy of nations which differ in their institutions from the capitalist countries. These consequences may go down in history as the greatest monument to the arrogant self-assurance of some of science's servants." (McFarland, 1991, p.v).

The focus of this paper is to examine the role population dynamics plays in influencing such adaptive ability. Our main claim is that social and political conflict is a function of the adaptive capacity of society. We argue further that the effect of population change on society's adaptive capacity is context specific. No general theory exists that encompasses all situations. The real world is inconveniently complicated. Analyses can only produce conditional and tentative conclusions that are short of universal generalizations.

The effect of population change on society's adaptive capacity depends, among other things, on the structure of the social, ideational and political systems. That *structure* includes, for example, the degree of society's ethnic and cultural homogeneity and the degree of equity in the distribution of its income, opportunities and political power. The effect of population change depends equally on the ability of existing *institutions* to introduce necessary changes and, meanwhile, have themselves the capacity to adjust to such changes. We agree that the evolution of institutions is path-dependent. The atomistic Newtonian paradigm needs elaboration as to how history, present circumstances and expectations *interact* to influence institutions through the *aggregate* of individual decisions and behavior. There are three sets of *institutions* that, for purposes of the present discussion, define the social structure of society: government and governance, economic and social institutions.

II. Population trends and the demographic system

In this section, we review some key population trends. The review serves as the basis for interpreting the consequences of these trends. To facilitate the discussion, demographic concepts are defined and some basic demographic system identities are introduced. The relation between population change and conflict is a policy-oriented subject. Policy analyses include four levels: descriptive, explanatory, predictive and evaluative. Formal demography provides the tools and technical language to measure and describe the levels, movements and

interrelations among the three basic components of population change: mortality, fertility and migration. Descriptive demography also provides population projections. These are essentially scenarios that specify, given the initial age structure, the boundaries and limits within which population change could occur over time. The level of explanation, prediction or the cost-benefit evaluation of demographic phenomena, however, is beyond the basic tools of technical demography. Here, demographic analyses must join hands with a large number of other methodologies and disciplines that range from biology, economics, and sociology to political and environmental sciences.

A simple but fundamental demographic accounting identity relates population growth r(p) to its basic components as follows:

r(p) = Crude Birth Rate - Crude Death Rate + Net Migration Rate, or

r(p) = **CBR - CDR + NMR**

(1)

The size of **r**(p) depends on the difference between the two vital rates of birth (**CBR**) and death (**CDR**), assuming international migration (**NMR**) is not a significant factor. Not immediately obvious, from equation (1), is the presence of a direct relation between the level of fertility and the age structure (or the age pyramid).

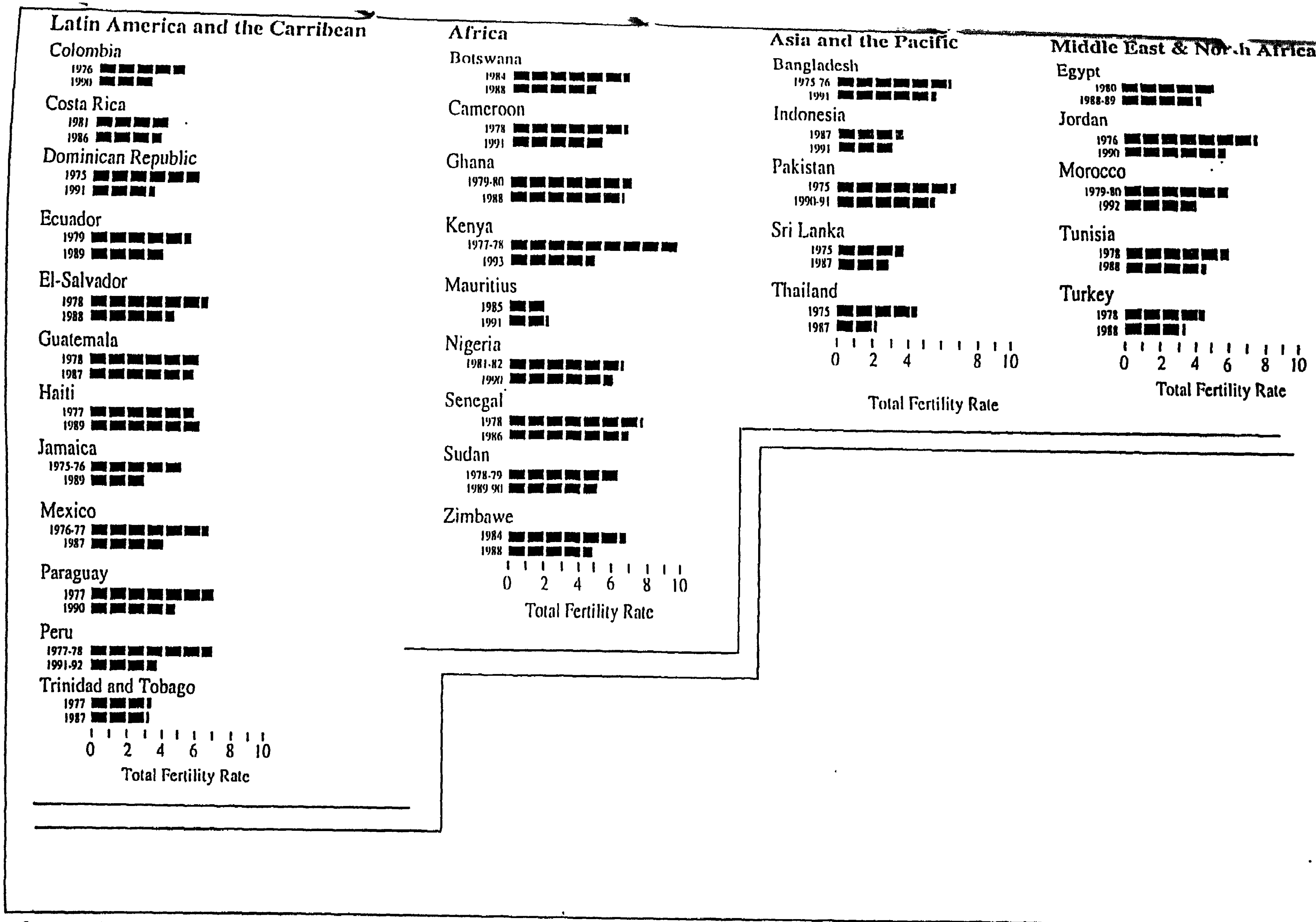
High fertility that persists for a few generations produces a young age structure where the bottom of the age pyramid is fairly wide. In this situation, the young, say those under age fifteen, compose a large proportion of the population, typically 40% or more compared with about 20-25% in societies with older age distributions. Whereas the old, say 65 and older, make up less than 5% of the total population compared with 15-20% in older age structures. This pattern of high fertility and young age structure has been the typical case in almost all the developing countries through the 1970s. With fertility continuing at relatively high levels, the remarkable decline in mortality that started in the 1950s did not have a significant effect on the young pattern of the age distributions in the developing countries. Its main effect has been to produce high rates of population growth[1] .

A systematic decline in fertility in some developing countries started in the late 1970s. It was led mainly by East Asian countries; Korea, Taiwan, China, Hong Kong, and Singapore experienced a remarkable decline. These were joined more recently by Thailand, Malaysia and Indonesia. By the late 1980s, fertility in most of the developing countries, regardless of the level of their development or cultural background, seems to have started a sustained decline. On the whole, birth rates have declined by one third since the mid-1960s: women formerly had six children on average, but only four by the beginning of the 1990s. This apparent trend led some observers to conclude that:

"The developing world is undergoing a *reproductive revolution*. In contrast to the classical demographic transition, recent evidence suggests that birth rates in the developing world have fallen even in the *absence of improved living conditions. The decrease has also proceeded with remarkable speed. Developing countries*

appear to have benefited from the growing influence and scope of family-planning programs, from new contraceptive technologies and from the educational power of mass media" (Robey,Rutsien & Morris, 1993, p. 60). Some observations on this *'reproductive revolution'* are in order.

1. These trends are not universal. As indicated in **Figure 1**, the decline in fertility



Source: Robey, Rutstein & Morris, 1993

Fig. 1. Fertility rates and their relation to education and birth control in some developing countries.

has been lagging in some regions and countries, i.e., the Sub-Saharan Africa and some Arab and South Asian countries. It is true that family planning programs have influenced the fertility decline. The size of the *net* effect, however, especially its independence of the level of development, is open to question. For example, Bongaarts, Maulding & Phillips (1990) conclude that the absence of family planning programs worldwide would have led to an increase in the total fertility rate of the low income countries by 1.2 children over its 1989 level, or about sixty percent of the total fertility decline experienced by these countries. In contrast, Schultz (1993), using pooled cross-sectional data and estimating a reduced form equation, finds a relatively insignificant net effect for family planning programs:

> "if the mean level of family planning score had not been 34 but zero, the associated TFR would have been 0.3 more" Schultz, 1993).

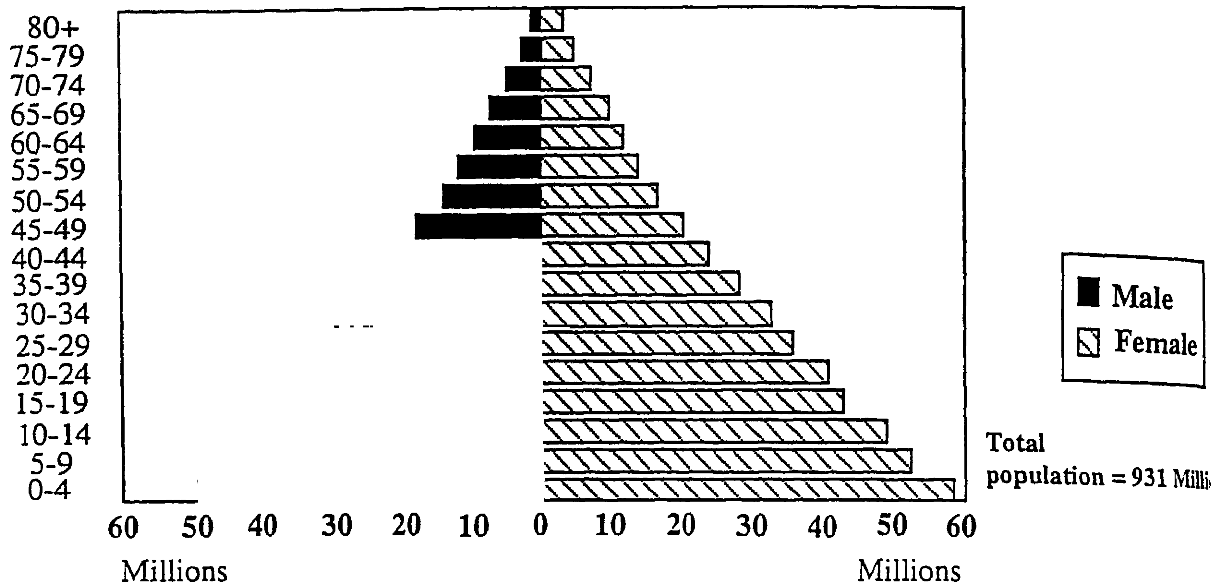
Schultz acknowledges the presence of various styles of development that are associated with different sets of structures and constraints, and modeled fertility behavior subject to some structural constraints. However, the analysis falls short of presenting a theoretical underpinning of the role of institutions in the evolution of these structures. This theoretical gap could result in errors of specification and of interpreting the results. For example, the hypothesis that countries with rich oil reserves will act within a micro-bargaining framework ignores how government and political institutions function. The emerging system of 'incentives' is a compromise between political and ideational forces. Its consequences to fertility are context-specific and often mixed. (Sirageldin, 1992). Also, disregarded is the role of ideational institutions. Once a significant relation between economic constraints and fertility in Islamic countries was found, Schultz hastened to dismiss the relevance of ideational and cultural institutions. He concludes:

> "The relatively high levels of fertility in Islamic countries are explained here in terms of the underlying economic constraints on the population, including past educational investment in women. One does not have to resort to *ad hoc cultural variables to explain most of the variation in fertility across low income countries*" (Schultz, 1993,p. 30).

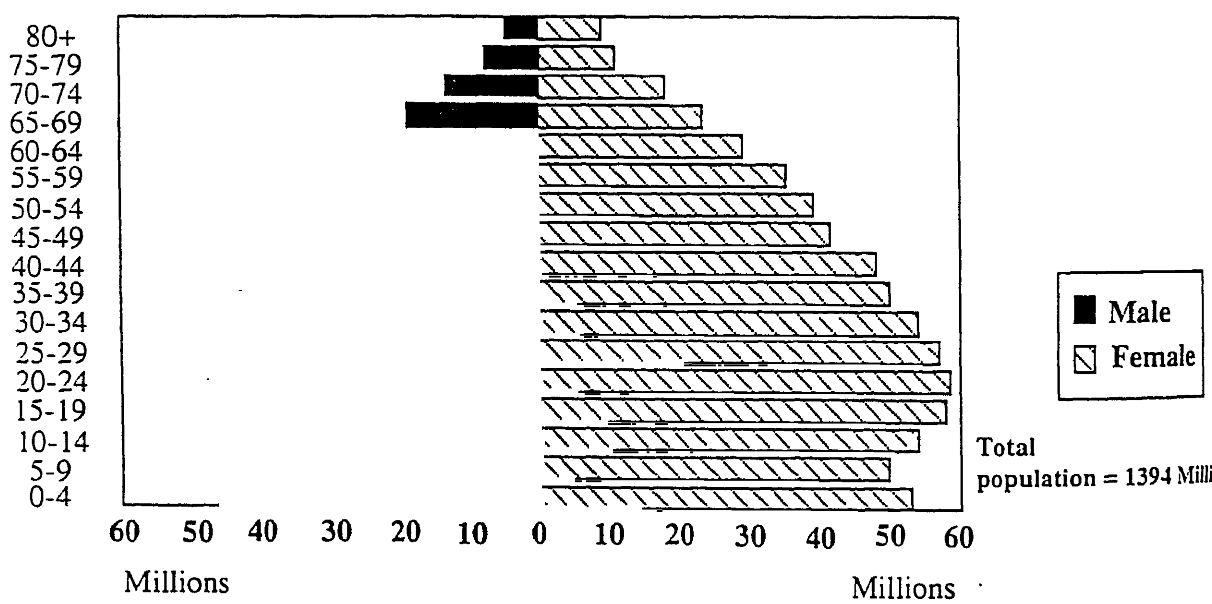
Institutions were not part of Schultz's paradigm. Schultz's statement is based on a "pure" neo-classical paradigm that regards *economic* incentives as the supreme power that shape micro *socio*-economic behavior.[2] This view is probably true in the long run since institutions do adjust eventually. It is important, however, to understand the determinants of institutional rigidities. Institutions that do not adapt, even for short periods, could impose high social costs in the longer term. For example, the delayed fertility response in Syria to a high degree of social change that included a significant improvement in the status of women is probably adding constraints to the country's development possibilities (Courbans, 1994).

McNicoll, (1994) on the other hand, argues convincingly that institutions should be an integral part of fertility analyses, even at the cost of less formalism. Variation in fertility trends is expected because institutions differ significantly among the developing countries. He presents a fivefold typology of broad patterns of fertility transitions. Patterns of transitions depend on the types of existing institutions. We must be wary of generalizations, McNicoll cautions.

2. Despite the observed decrease in birth rates, the world population will continue to grow at high rates. It is expected to double to 10 billion by 2050. For some countries, the increase will continue well through the middle of the next century. The reason for the large increase in population size in the face of declining fertility rates is the '*momentum*' built into the young age structure of the populations of the developing world. For example, if India adopts a replacement level of fertility immediately, its population will continue to grow until the sizes of its various cohorts equalize, thus reaching a *stationary* state. In this transition, India's age structure will change from its original young 'triangular' shape towards a stationary 'rectangular' shape, as illustrated in **Figure 2.**



Jnited Nations 1993



United Nations 1993

Fig. 2. Projected Age Structure of India: (a) 1995; and (b) 2025

3. Moving from a young age structure, typical for all developing countries, towards a stationary state, a population will increase in size. That increase will be greater the 'younger' the initial (stable) age structure. Furthermore, that increase in population size will be concentrated in that part of the population above 30 years of age. This process is illustrated in **Figure 2** for the case of India. In this hypothetical case, between 1995 and 2025, the *size* of the 30-35 age group can be expected to increase from about 70 to 100 million people. In this scenario, for those who are less than ten years of age, population size declines from about 230 to 210 millions.[3]

4. The socio-economic significance of the concentration of growth in the older age groups (over thirty years old) needs no emphasis. It is probably a major source of conflict in the process of population change. It increases the supply of potential workers in society. It also increases the relative claims of the elderly. If output and productivity do not increase fast enough, unemployment, forced population movements and the potential for inter-generation conflict may arise. These negative consequences of an aging population could reduce the prospect for development. In that respect, an exogenous decline in fertility that is independent of the level of development, as observed by Robey, Rutstein and Morris (1993), should not be a cause for unqualified celebration. Fertility reduction is not a development objective. It is one of the instruments used by a society to achieve higher levels of welfare. To represent a viable paradigm for development, such exogenous fertility reduction should generate its own internal dynamics for development. A process not well articulated in theory or fact, especially when recalling the experience of the developing countries with the mortality transition. Otherwise, we are left with a worse-case Malthusian world, where the socio-economic burden of an aging society is added to the usual Malthusian case of a costly struggle between reproduction and production that revolve around marginal subsistence, famine and social conflict. Such a case was labeled a "standstill" scenario, in contrast to a fertility reduction that is part of a sustained "development transformation," (Sirageldin, (1991).

5. Concentrating on fertility and its effects on the age structure ignores other important consequences of fertility decline. An established high level of fertility reflects a structure of local values, traditions and social contracts. That structure represents the foundation and stability of the existing social and political order. It is both a consequence and a cause of an established distribution of income, wealth, power and authority. New patterns, especially those perceived as foreign, pose serious challenges to the privileged status of the existing authorities. Such challenges do not proceed without resistance. It is emphasized that, even in social structures that have been established for long periods, values are not universal. At any time, there exists a certain degree of value heterogeneity. This should not be confused with the continual changes in the 'overall' value system being induced through innovations and technical change. Institutions, using McNicoll's (1994), terms dealing with material

realities, *evolve* as a result of the introduction of new technologies or of changes in environmental conditions. Changes in material conditions are associated with changes in the distribution of wealth and privileges. These changes require a parallel evolution in the ideational institutions to rationalize and give coherence to the new distributions of roles and privileges. The two institutions, material and ideational, must evolve in concert. If changes in the material sphere are sudden, large or proceed at a fast pace, adjustments in ideational institutions could be resisted or lag behind. The result may be costly conflict.

The policy challenge is to maintain the diffusion of social and technological innovations within the ability of society to absorb its 'new' value implication. That challenge is not always met, partly because *the institution of government* is not free to act independently of the distribution of political and economic power, whether internal or external. Who benefits from the state's action cannot be inferred a priori from the atomistic paradigm:

> "If such development-induced change proceeds too fast, relative to the ability of the social system to absorb it [to become endogenous to society], resistance to change may turn into revolt against change and ignite revolution against the established regime. The result of these dynamics could be *the emergence of a new development paradigm that builds upon threatened traditions, or an attempt by the established regime to accelerate the process of change...* Established regimes may fear the loss of legitimacy and may divert scarce resources to security issues through costly repressive means or through a non-sustainable system of subsidies and employment guarantees, away from their countries' long-term development priorities. Alternatively, established regimes may seek alliances with foreign powers that, on the surface seem to be an attempt to accelerate the modernization effort, but mostly are attempts to seek protection against the opposing forces that represent established traditions" (Sirageldin, 1992, p. 50).

6. Migration is the third element in the demographic accounting of **Equation 1.** Migration is probably the most important population factor underlying the overall stability of the socio-economic system, at least in the short-run. In its free perfect market scenario, migration, by responding to market signals, improves overall efficiency of the economic system. Imperfection in market behavior that restrains change and reduces factor mobility leads to efficiency losses. For example, resistance to change depends on:

> "...the structure of the social system, the degree of its openness, e.g., acceptance and assimilation of immigrants. A tribal social system, a commune Chinese-type, a canton Swiss-type system, or a subsistent rural community are examples of relatively closed systems with strict socialization processes that limit the domain of individual mobility." (Sirageldin, 1992, p. 50).

The control of immigration as a legitimate exercise of national sovereignty is not much disputed in international law and relations; however, such movements whether legal or not do occur, on a large scale. In many instances, the results create conflict and violence. For

example, it is estimated that in 1992, there were 21.6 million refugees around the world. These were distributed as follows: 9.89 million refugees in Asia, 5.39 million in Africa, 4.38 millions in Europe, 1.04 million in North America, 0.89 million in Latin America and 0.06 million refugees in Oceania (Population Action International, 1994). Movements of refugees are partly a result of conflict in areas of origin and a cause of conflict in areas of destination. The relation between international (*or internal)* migration and conflict is well established. Causes include lack of cultural, political or economic integration (Van Arsdol, 1985; Choucri, 1984).

It must be noted, however, that although the economic and social consequences of migration seem current and visible, its determinants could be a result of deep-rooted historical foundations. It could be triggered by unexpected and sometimes irrational incidences creating costly conflicts. There are many such examples in recent history as well as in today's world.

III. Modeling population change and conflict

Population and Development

Population dynamics is a subsystem of the larger socio-economic system. The demographic identity of **Equation 1** could be incorporated in a larger identity that relates population growth to the growth rate of national output. That latter rate includes the rate of *net* human and physical capital accumulation as follows:

$$r(p) = r(Y) - r(y) \qquad (2)$$

$$r(y) = (S/K) - (CBR - CDR + NMR) \qquad (3)$$

Where, r(p), r(Y), r(y), S and K refer to rates of growth of population, GNP and per capita GNP, the saving ratio and the incremental capital output ratio, respectively (Sirageldin, 1991).

On a descriptive level, the left-hand side of **Equation 2** indicates net human capital formation (additions to population with a given composition of knowledge, skills and abilities) and the right-hand-side indicates physical capital accumulation. **Equation 3** illustrates that to maintain the same living standard of [r(y) = 0], invested saving (S) and productivity (K) must provide for net additions to the population [r(p)].

However, development implies more than accommodating net additions at the same standard of living. It implies an attempt to improve living standards for present and future generations. Representing the gap between current and desired status by **d**, **Equation 4,** represents required system adjustments as follows:

$$d\,[r(y)] = d\,[(S/K) - (CBR - CDR + NMR)] \qquad (4)$$

Although an identity, **Equation 4** indicates that to accommodate the desired change, adjustments must be made in the socio-economic, demographic and technological components

of the system. Regardless of the model employed, these are not marginal adjustments of socio-economic processes (Sirageldin, 1992). They include basic interrelated structural transformations: human capital, agricultural, technological and, institutional, among others.

An example of the interrelation between demographic and agricultural transformations is given in Sirageldin (1993). Both transformations must act in concert. It seems rather impossible to increase significantly labor productivity in agriculture, for example, through a massive mechanization program without an equally massive spatial and occupational mobility in the short and medium terms, and a parallel decline in fertility to insure stability in the longer term. (Sirageldin, 1993). The interactive nature of migration and fertility on the stability of the socio-economic system is often overlooked. For example, it was found that rural-urban migrants are selective on low fertility. The implication is that high rates of rural population and labor growth will continue for longer periods in the future. Accordingly, agricultural transformations that attempt to improve labor productivity through the adoption of labor-saving technologies will generate pressure on the non-agricultural sectors to increase their labor absorptive capacity. A challenge that seems to fail more often than not. Ahmed & Sirageldin (1993) found significant selectivity bias by fertility among Pakistani migrants--rural-urban migrants were selected on low fertility.

The developmental policy challenge is to facilitate and achieve, with minimum social and environmental costs, a sustainable completion of these transformations, by minimizing the imbalances between the two basic accumulations of human and non-human capital.. Imbalances between human and non-human capital accumulation do occur, however, in the normal course of socio-economic change. Population growth may exceed or lag behind the rate of non-human capital accumulation and the growth of either accumulation may exceed environmental tolerance. The question is: under what conditions are societies able to cope with imbalances without resort to violent conflict? In many instances, within institutional and technological limits, societies can cope with demographic imbalances. A celebrated mechanism is through the evolutionary introduction of labor intensive techniques in agricultural production that increase the demand for labor. [cf. Boserup, 1965)

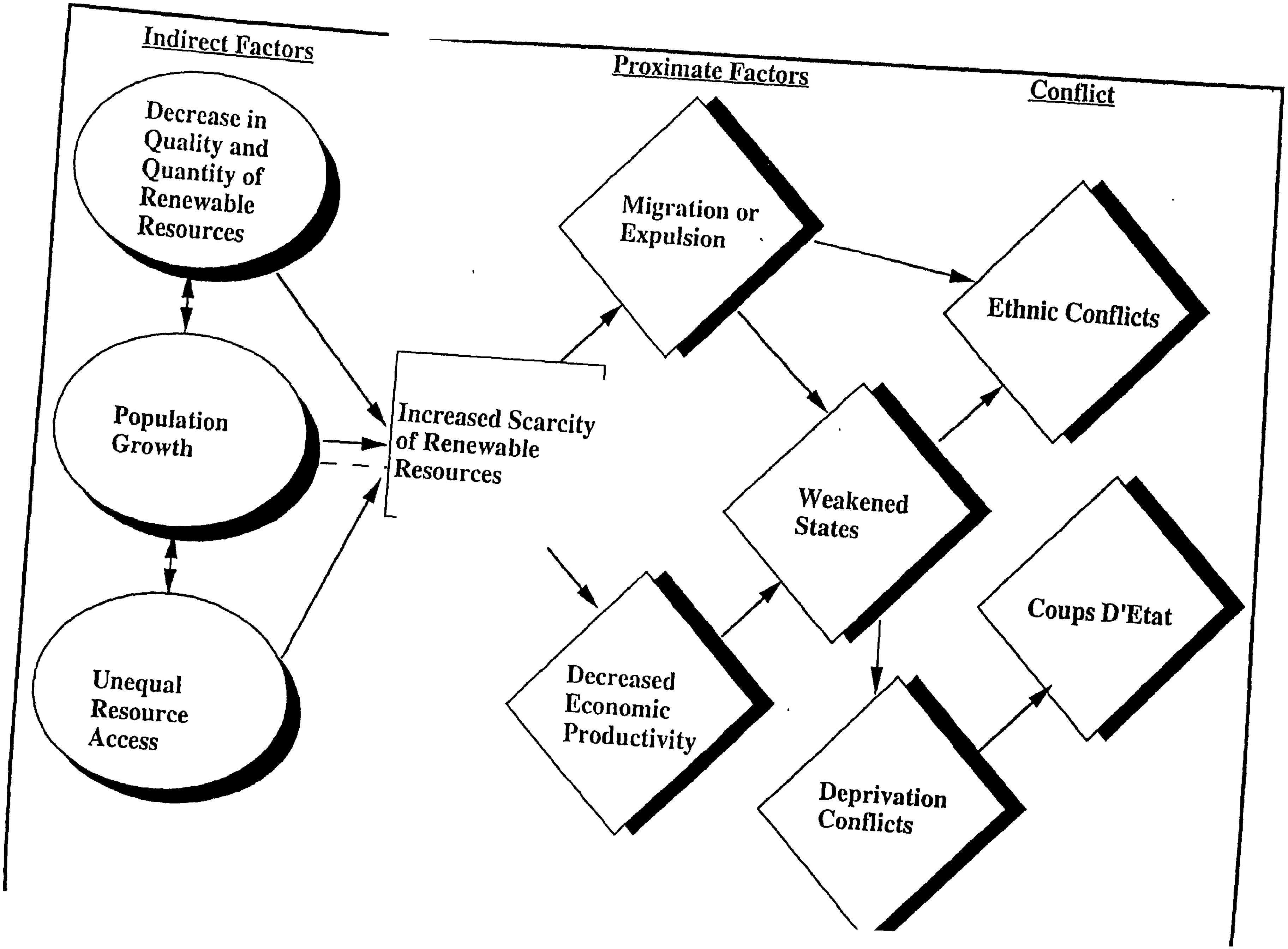
Beyond such limits, however, where imbalances are associated with unemployed resources or unfulfilled aspirations, demographic forces take hold through increased mortality, reduced fertility, or forced migration. These may be associated with costly unrest and conflict, within or between countries, that reduce society's capacity to deal with the imbalances and develop. What are the conditions for such developments?

Population and Conflict

What is the mechanism through which population changes create conflict? Clearly, there is more than one mechanism: resource scarcity, migration, expulsion, decreased economic opportunities, or famine conditions. There are also many types of conflict: ethnic or religious

conflict, deprivation conflict, or coups d'etat. There are also various conditions that may enforce the relation between population change and conflict: inequality in access to resources or opportunities, ecosystem vulnerability, inefficient or weak governance and inefficient market functioning, among others. Population is but one variable in a series of political, economic, social and environmental factors that can bring about turmoil and conflict. It is our view that the causal process that links population to conflict is contingent on the presence of these other factors. Two factors play important roles: unequal access to resources and the value imports of the modernization process in practice.

Lack of access to two basic renewable resources, water and cropland, when combined with high rates of population growth seem to ensure serious conflict. **Figure 3** based on Homer-Dixon, Boutwell and Rathjens (1993) presents a framework that links the various factors, including population, to various types of conflict.



Indirect Factors
Proximate Factors
Conflict
Decrease in Quality and Quantity of Renewable Resources
Population Growth
Unequal Resource Access
Increased Scarcity of Renewable Resources
Migration or Expulsion
Decreased Economic Productivity
Weakened States
Ethnic Conflicts
Deprivation Conflicts
Coups D'Etat

The left-hand side of **Figure 3** lists the three basic sets of factors that influence conflict *indirectly* through a set of proximate factors. These *indirect* factors include renewable resources (water and cropland), population change and unequal access to resources. Negative change in these three sets of factors leads to increased scarcity of renewable resources. Scarcity of renewable resources increases the migration rate as well as migrants' expulsion. It also decreases economic productivity. The combined effects of these two *proximate* factors affect conflict directly and indirectly through their effects on the strength of the state. Migrants' displacement and productivity decline reduce the state's revenue while the state increases its spending as it deals with the deteriorating circumstances. The result is to weaken the financial and political ability of the state. The combination of forced migration, decreased productivity and a weakened state leads eventually to deprivation, ethnic or religious conflict, and finally coup d'etat.

The strength of the Homer-Dixon, Boutwell & Rathjens (1993) framework (referred to hereafter as HBR framework) lies in its simplicity, clarity and flexibility. Although lacking some important feedback linkages, it serves as a starting point for the preliminary analyses of specific case studies. Important feedback linkages that are missing from the framework include those between environmental and population changes. These are illustrated by the dashed lines in **Figure 3** (not included in the original **HBR** framework). A more detailed specification of the role of population dynamics was attempted by **HBR** in their analysis of the case of the Philippines. This is illustrated in **Figure 4**. Here, the population factors play a prominent role; however, their role continues to be exogenous to environmental and economic conditions. A fuller understanding of the role of population in this dynamic system should incorporate these feedback linkages; however, the cost is an increase in model complexity.

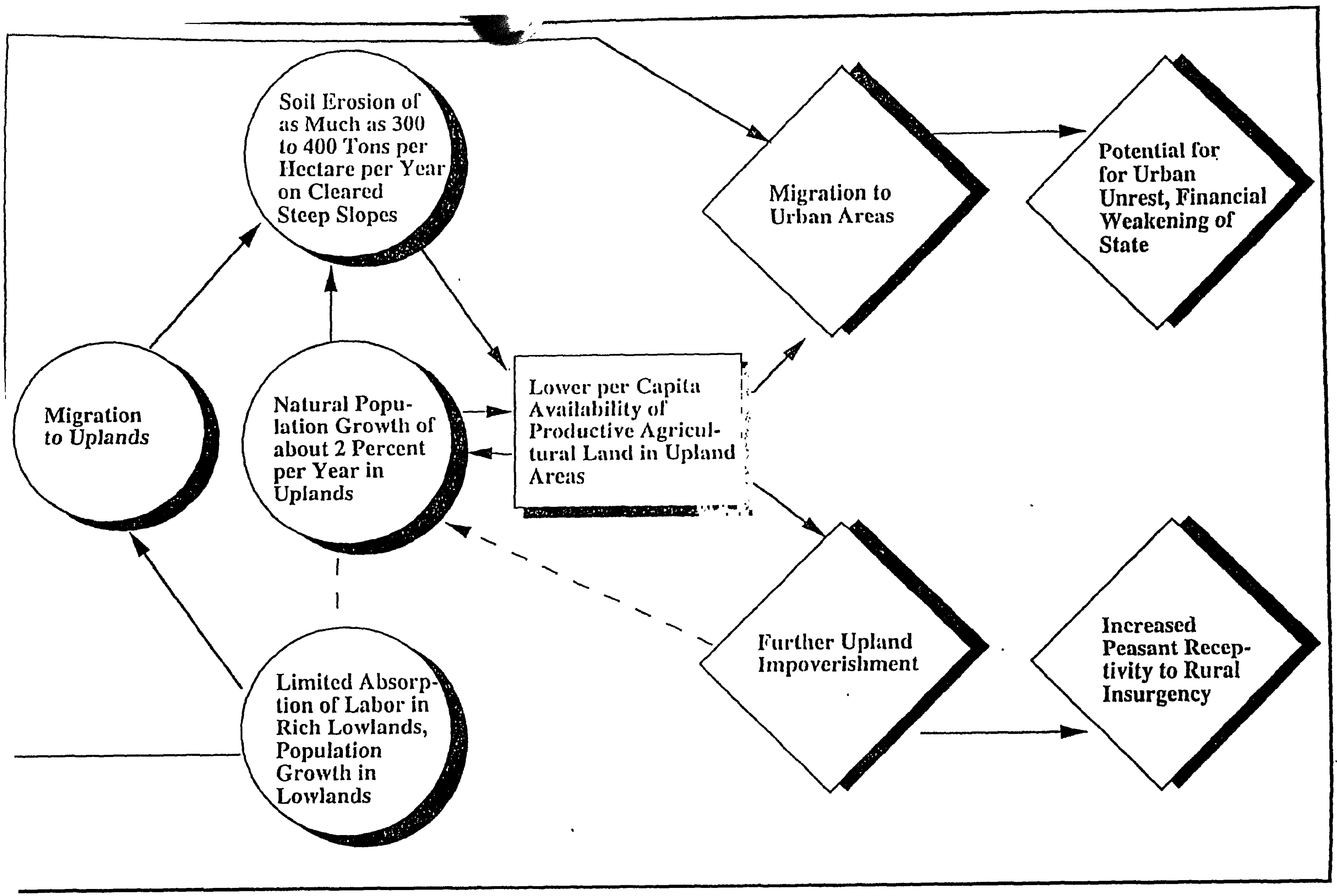


Fig. 4. Some sources and consequences of renewable resources scarcity.

The simplicity of the **HBR** model helped to focus on the main policy issues. It tells the following story about the Philippines experience. There are lowlands and uplands. The lowland is rich, has a high population density and high rate of natural increase. The lowland is exceeding its carrying capacity and provides limited labor absorption capacity. People from the lowlands start emigrating to the uplands; however, the natural rate of population growth in the uplands is already high. The result is more cultivation of steep slopes, increased soil erosion and reduced per capita availability of productive agricultural land in upland areas. Upland welfare deteriorates. Upland populations become less receptive to immigrants and, migration streams are redirected towards urban centers. The combined effects of these forces led to conflict as follows:

1. Migration from lowland to upland created resentment in the receiving area.
2. Both types of land experienced a decline in productivity, leading to the erosion of the state's tax base.
3. As a result of reduced productivity and labor absorptive capacity in both lands, migration streams moved to urban areas. The result is increased crime rates and deteriorating health and social conditions, leading to conflict.
4. The weakened economic and political status of the state limited its ability to deal with reduced agricultural productivity and to improve deteriorating urban socio-economic conditions.

The story is revealing and fits the Philippines setting at the time. It also leaves some puzzling questions unanswered. There is a sense of unidirectional causation that suggests an inevitable outcome insensitive to economic or demographic feedback. What are the factors responsible for the absence or ineffectiveness of the feedback mechanisms that could provide signals to steer society from such a disastrous course? And, ultimately, what is the role of public policy in this scenario, especially in the early stages of its development? To answer this last question, the model needs to incorporate 'a theory of government' to introduce policy parameters and investigate farmers' and migrants' responses to such parameters. Reduced that reduced fertility today will not reduce the rate of growth of the labor force today or tomorrow. Jobs need to be created at an increasing rate to deal with the historic determinism of the age structure; however, postponement of the fertility decline will only exacerbate future consequenees.

What is missing from the **HBR** framework is the role of social values, ethnicity, religion and racial tensions. These ideational factors are probably easier to use as control variables than to model. They also interact with economic and resource availability factors. Their net effects are hard to estimate or predict; however, they seem to be on the forefront of most of today's international conflicts. For example, there are many cases of religious related conflict in today's world. Although current, their roots go far back in history. The cases of Northern Ireland, Bosnia, and the recent polarization of Islam and Christianity as two

cultures in conflict are illustrative. In a recent work, Huntington (1993), conjectured that future conflict in international relations will be based more on a clash between cultures or civilizations rather than between or among nation-states. Among the six dominant cultures in today's world, illustrated by Huntington as potential sources for future conflict, the confrontation between Islam and the West is illustrated by him as the most likely case (Huntington, 1993) We disagree with various parts of the intellectual framework presented by Huntington, especially as it portrays the 'West' and 'Islam' as two homogeneous entities. Furthermore, it does not cover in sufficient detail the interactive nature in the development of the two cultures, that is, whether their historical paths were independent. On a more basic level, one may question Huntington's claim that clashes based on cultures or civilizations represent a *new* direction in international relations. The history of major conflicts, from the Crusades, World Wars, the Cold War era or the North-South confrontation that followed, has been a history of clashes based on differences in ideology and systems of political economy that went beyond the nation-state. It is a history of the development of capitalism e.g., (Amin, 1992). Huntington's analysis, however, is a good reading of historical events. It illustrates the role religion may play (or may be played with) in generating conflict on a worldwide scale. It is also a reminder that enhancing the adaptive capacity of institutions to deal with internal conflict goes beyond national boundaries.

The **HBR** framework is equally silent on the adaptive capacity of social institutions How institutions evolve and adapt seems to be outside the framework. The aforementioned case of the Philippines illustrates this gap. The ability of institutions at various levels of authority (from individual to corporate) to anticipate and deal with these events, in order to minimize their negative consequences, was not discussed. Accordingly, important policy questions were left unanswered. Could *the state* play a more positive role in such situations? If yes, what would be the optimal scope, size and timing of the state's intervention?

The Role of the State

An important characteristic of a society that succeeds in reducing overt conflict is its ability to adjust to changing circumstances and take advantage of opportunities. The role of the state in promoting such an environment has become an increasingly controversial subject in recent years. For example, what is the degree of efficiency implied in the *markets* of **Figures 3** and 4? And what is the role of the government in that case? The **Figures** clearly imply a strong role for the state. This role is also implied in the Robey, Rutstein and Morris (1993) discussion regarding the efficacy of family planning programs with strong public support and commitment.

The weakening of the state is taken as a <u>result</u> of adverse economic and social conditions and a <u>cause</u> of the state's inability to act as an effective agent for development. But adverse economic conditions inevitably lead to conflict that a weak state cannot resolve

Evidently, there is a dilemma as to the appropriate size and scope of state activities, especially in its role as an effective agent of development, while the present dominant economic ideology calls for minimal government:

> "Dwindling natural resources can weaken the administrative capacity and authority of government, which may create opportunities for violent challenges to the state by political and military opponents. By contributing to rural poverty and rural-urban migration, scarcity of renewable resources expands the number of people needing assistance from the government. In response to growing city populations, states often introduce subsidies that distort prices and cause misapplication of capital, hindering economic productivity. Simultaneously, the loss of renewable resources can reduce the production of wealth, thereby constraining tax revenue. For some countries, this widening gap between demands on the state and its capabilities may aggravate popular grievances, erode the state's legitimacy and escalate competition between elite factions as they struggle to protect their prerogatives" (Homer-Dixon, Boutwell & Rathjens, 1993, p.43).

There seems to be a general consensus that the state should promote the conditions for an adaptive economy. But what do we mean by a flexible or an adaptive economy. This is apparently a narrower concept than our earlier definition that included both 'technical' and 'social' sustainability and encompasses both material and ideational institutions. The term, 'adaptive economy' has been discussed in great detail by Killick (1993):

> "Expressed in its own terms, *a flexible economy is one in which ends and means are readily adjusted to changing constraints and opportunities*. These include flexibility in *institutional* base of the socioeconomic system, as well as *flexibility on the part of the government* in adapting *policy to changing conditions*. It implies an economy in which movement of resources among alternative uses is relatively low friction, low cost, and rapid and leads to changing factor proportions, technologies, and composition of output... Given the *information and incentives*, the second set of conditions relates to *people's reactions to these stimuli, that is the responsiveness to economic signal*" (Killick, 1993,p.47. emphasis added).

Killick's definition of an adaptive and flexible economy implies a role for the state that is neither specified in size nor in scope, especially as it relates to his second set of conditions. For example, the state's responsibility in setting both *ends* and *means* is a controversial policy question of great social, political and economic consequences. It is central to identifying the proper balance between *freedom and organization*. To illustrate, following Huntington's conjecture discussed earlier, a recent survey of Islam and the West as two competing civilizations (The Economist, August 1994) indicates the importance of the aforementioned policy question and the difficulty of providing a satisfactory answer for it. In that survey, the author argues that 'life in the late-20th-century western world seems increasingly atomized. The price of atomization, without moral guidance is increased isolation

where people live as individual units rather than as members of a team, whether at home, at work or even in leisure activities. According to that survey, the price of atomization in the Western culture is:

> "Paid, in one way or another, by almost everyone: the breakdown of the family, people .. grow more callous and more violent, the means of violence .. are more readily available and more affordable, so are the things that tend to reduce self control, such as alcohol and drugs. .. This is why it is beginning to be argued that the West *must* find a way of putting individual initiative, the *necessary driving force* of progress, *within a shaping moral order, which is the only way of defining what the word 'progress' means."* (*The Economist,* August 1994, p. 17)

The issue of atomization as a value system goes beyond the Western notion of setting a high value on individual independence rather than interdependence. In its origin, this notion derived comfort from the Newtonian system of the equilibrium of forces at the margin. In their behavior, the Newtonian atomistic actors tend to converge towards an equilibrium solution that is always optimal, regardless of their initial arrangement. The operation of the system confirmed the metaphysical belief that individual actions are being guided by an invisible hand that always tends towards the best of all possible worlds. God with His vision of the 'Good Society' is in full control. This 'comfort and belief' in a 'controlled system' that produces the good outcome is being questioned. The system and its desirous outcome seems to be moving out of control. Individual behavior and its collective outcome seems to be controlled more by a value system of an emerging 'technical society' that elevates efficiency to a supreme status. The technicalization of a human society is essentially a dehumanization of that society. Progress is equated with efficient production without regards to *for whom* or *what* is being produced. Even violence, whether on the individual, communal or international levels, is being treated like any other commodity, and assigned a value that is proportionate to the efficiency of its production. In essence, the 'New World Order' is characterized by the emergence of a universal culture that is neither Western nor Eastern in substance. The consequences of this new culture to the peaceful coexistence of the human race, the survival of other species and the sustainability of the environment are uncertain at best.

Should economics be silent on such issues of morality? Many economists feel that they should not. In an exhaustive survey, Hausman and McPherson (1993) take the position that economics should deal with moral issues. They argue that although economists in the last twenty years have renewed their conversation with moral philosophers:

> "There remain considerable gaps between the modes of expression and habits of thought. [However] An economics that is engaged actively and self-critically with the moral aspects of its subject matter cannot help but be more interesting, more illuminating, and *ultimately more useful* than one that tries not to be" (Hausman and McPherson, 1993, p. 723).

The West, the 'Economist Survey' argues, could borrow from the moral philosophy of Islamic civilization, since:

> The distinguishing feature of Islam, which at the moment separates it from all of today's other would-be global cultures, is its belief not only that man's day-to-day visible life is surrounded by an invisible life but also that the two have to be kept in connection with each other. (The Economist, 1994, p.16-18).

This vision of Islam as a complete system that rejects a 'total separation between ethics and economics' is universally accepted among Muslim scholars (Sirageldin, (1992).[4] This vision of Islam as a complete system implies a closer connection between the material and ideational institutions. Such close 'coordination' implies a strong *role* for the state. A *role* rendered more difficult in the presence of competing moral theories available for leaders and policy-makers to guide their overall assessment of economic institutions and outcomes. In their survey, Hausman and McPherson (1993, list and discuss in some detail four kinds of moral theories: (1) those that focus on efficiency; (2) libertarian theories; (3) utilitarian or consequentialist theories, and (4) contractarian theories; There conclusions are illustrative:

> Few economists can avoid ever making appraisals of economic outcomes or institutions, and in making such appraisals they unavoidably rely on some moral philosophy. .. Very little in ethics is completely uncontroversial, and very little can be said about economics that relies on only uncontroversial moral premises. Economists concerned with evaluation are going to have their feet wet in the swamps of moral philosophy. (Hausman and McPherson, 1993, p. 711-1712).

Evidently, incorporating morality in economic management is vital but risky. Not surprisingly, the role of the state in promoting a 'moral society' was not discussed in the "Economist Survey", especially as it relates to equity versus efficiency, or freedom versus organization, in the context of an increasingly competitive global economy. This trade-off has been at the forefront of political economy for centuries. Going back to ancient Greece, the question of the limits of government was mainly a debate between "democratic participation" or giving the people control over public policy, and the ideal of "isonomy" or the certainty of being governed legally in accordance with known rules. That debate seems to continue uninterrupted through the present time. It is isonomy or the "Rule of Law" that Hayek (1955) seems to have elevated above the state authority and placed it as a justification for democracy. According to Hayek (1955, p. *34)*, for a legal system to be considered as constituting the Rule of Law, its "laws must be general, equal, and certain." The Rule of Law that embodies the basic elements of the "*Moral Society*" and that should be above the state and legislative authorities must adhere in some way or another to the "general" will of the public, in order to be consistent, at least with Hayek's last condition: *certainty of law* (a condition considered by Hayek as *supreme)*. It is probably the *supreme* challenge of our present age

of the "new world order" to find a practical resolution between these two basic ideals: isonomy and democracy. One difficulty arises from the attempt by the state to cope with the consequences of the universality of new technologies and the level and scope of international competition. States may not afford to resist the new economic order. But to accommodate it, while containing internal social and political conflict, they *tend*, with the likely blessing of the external economic powers, to impose more control and less democracy. This *tendency* has strong alliances from an emerging political economy that elevates market power above democratic participation, thus reducing people's control over public policy, a clear violation of Hayek's conditions for the Rule of Law.[5]

How much government is optimal? This is not an easy question to answer. As our previous discussion indicates: weak government leads to conflict, and conflict leads to inefficient allocation of resources, that leads to weak government. But more government may lead to inefficient resource allocation. It is not our purpose to go into the relative merits of market and planned economies. Such digressions often lead to conclusions that "all for the best in the best of all possible worlds". Evidently, there has been an increasing tendency in professional opinion, among politicians and those they represent, to place more emphasis on market efficiency and mechanisms. Most economies continue to be mixed, however. We should be able to identify the critical policy parameters in such an environment. As Killick (1993, p. 49) emphasizes: "However the balance is struck between the market and the state, we should note the importance of *adequate information flows*." Adequate information in this scenario improves the efficiency of the market and the political systems. This case was made strongly by Stiglitz (1988). An important role for the state accordingly is to improve information flows. We must be wary, however, of the possibility that free information flow, even in the present age of revolutionary communication technology, does not necessarily imply equitable utilization or reliable content. Information is often used, selectively, as a tool to serve political objectives even in established democracies (recall, for example, the use of the term "misinformation" to justify the presentation of "lies" in public announcements to promote governments' policy objectives during the Cold War era and beyond). Of more direct concern to the present discussion, is that, in many instances, people and small communities in the less developed countries, that are most affected by the negative consequences of large public and private projects, such as irrigation dams or chemical complexes, and who should share in the implementation decisions of such projects, are not well informed about consequences. This state of affairs has generated a heated debate about many World Bank projects undertaken in the 1970's and 1980's. It led to the establishment of the Environment Division at the World Bank and the inclusion of environmental consequences in projects' appraisal. It also led to a national and global concern about a more systematic study of environmental issues: their determinants and consequences including those of population dynamics. Also emphasized is the role of governments and international agencies in the wide dissemination of information

about environmental consequences, especially at the local level.

IV. Empirical illustrations

In this section, we examine the links between population change and two basic renewable resources, namely, water and cropland. The purpose is to elucidate the mechanisms that may trigger conflict and violence. The findings reported in the Homer-Dixon, Boutwell & Rathjens (1993) study, is an excellent base for the present discussion. Their report is based on findings from a team of 30 researchers whom they assembled to examine a set of specific cases relating environmental change to violent conflict. They focused on the two renewable resources of interest to the present analysis: water and cropland. Population was an important variable in their analyses. Their general conclusions are illustrative:

> "Evidence gathered points to a disturbing conclusion: scarcities of renewable resources are already contributing to violent conflicts in many parts of the developing world. These conflicts may foreshadow a surge of similar violence in coming decades, particularly in poor countries where shortages of water, forests and, especially, fertile land, *coupled with rapidly expanding populations*, already cause hardship." (Homer-Dixon, Buotwell and Rathjens, 1993. p. 38).

We start with the **HBR** definition of resource scarcity. Scarcity is produced in three different ways. First, it may result from degrading or consuming the resource at a rate faster than its renewal rate. Second, where the resource per capita declines as a result of a high rate of population growth. Third, where a change in the distribution of a resource results in concentrating supply in the hands of a few, subjecting the rest to extreme scarcity. We may also add, as a fourth dimension, ecological change that occurs independent of human actions.

Their first example of cropland scarcity refers understandably to the case of Bangladesh. Given the built-in population momentum, mentioned earlier, Bangladesh's population of 120 million is expected to double during the next 30 years. With an average density that is almost three times higher (2.75) than that of the neighboring Indian State of Assam, the seeds of conflict were already planted. Legal and illegal migration from Bangladesh to India have been a source of increasing conflict between the two countries and have created ethnic and religious tension and violence: "In the village of Nellie, Lalung tribespeople massacred nearly 1,700 Bengalis in one five-hour rampage" (Homer-Dixon, Boutwell and Rathjens, 1993, p.40.) At destination, migration creates a shift in the balance of political and economic power that is violently resisted by the original power structure. It essentially creates an explosive situation that could be triggered by unexpected and often minor incidences.

This case of cropland scarcity and high rates of population growth that exceeds the effective supply of a vital renewable resource illustrates some important points related to population dynamics and conflict. The momentum of population growth that has been built through generations of high fertility does not disappear suddenly. Under conditions of increased

resource scarcity, it triggers spatial movements that interact with ethnic, religious and racial origin to keep tension and violence alive through future generations. Increased density, coupled with a subsistence economy, leave little room for social or political adaptability. Environmental shocks, even minor ones, could easily trigger a chain of events that leads to forced migration and violent conflict.

Almost all areas of the world are experiencing a decline in cropland per person. The trend will continue well into the twenty-first century. This is mainly a result of the *population* momentum built into the populations of the developing countries. It is also a result of *a very low supply response* of available cropland. Asia, with the highest human concentration, has the lowest per person availability of cropland, about 0.15 hectare per person in 1989 that is expected to decline to 0.1 by 2025. In Africa, cropland per person was 0.3 in 1989 but is expected to decline to 0.1 by 2025. These trends in cropland availability per person, if not compensated by innovations in land use, will be a serious source of conflict through the next century.

The second case of the effects of cropland, water availability and population dynamics on conflict, mentioned in the **HBR** study, relates to the violence that erupted between Senegal and Mauritania. The violence seems to have been triggered by a complicated set of factors including a cooperative regional project: the building of the Manantali Dam on the Bafing River and the Diama salt-intrusion barrage. Population growth in this part of Africa exceeds two percent per year. With a very young age structure, the prospect for future increase is guaranteed for many decades to come. According to an FAO report, quoted in HBR, the three countries of Mali, Mauritania and Senegal were included in the critical list of countries whose croplands cannot support current or projected populations without a large increase in the use of fertilizer and water for irrigation. More intensive cultivation of existing cropland is deemed impossible without increased water resources. The situation was considered a matter of survival. Accordingly, the three countries agreed to develop these joint irrigation projects with the blessing and financial support of the international community.

The project was considered by the international development agencies as a model for regional cooperation in the Sub-Sahara region of Africa. However, the combination of the structure of political power, unequal wealth distribution and ethnic composition in these countries produced unexpected outcomes. The announcement that the dams would be built created expectations of rising land values. In Mauritania, the elite, mainly Moors, used their power to take advantage of the situation. They succeeded in changing legislation governing land ownership in their favor. The change in legislation effectively deprived a large segment of the population of cropland ownership. These were mainly non-Moors. Ethnic violence erupted when, in 1989, some Senegalese farmers were killed in Mauritania. This triggered a chain of events that led to ethnic conflict and violence in the two neighboring countries. The events included confiscation of properties, expulsions and forced migration of nationals

and finally violence. These events were further exacerbated by attempts on the part of the privileged groups to exploit the situation further and seize even more. The two countries were close to the brink of war.

The forces of population dynamics, especially high growth rates and uneven distribution of wealth and political power, have created an increased scarcity of renewable resource endowments. The attempt to deal with the short-run implications of the situation by improving the productivity of cropland through vertical technology required action by the state that implied some difficult decisions regarding the distribution of gains and losses. These difficulties arose mainly from the presence of an unequal distribution of political power that controlled the behavior of the state, and that ran mainly along ethnic lines. On the other hand, long-term solutions that require a reduction of the excessive rates of population growth and a more efficient allocation of scarce resources for sustainable development were not forthcoming. This was the case primarily because of the structure of existing social and political institutions. In the absence of long-run development vision and action, the potential for future conflict can only increase. It is evident, however, that the role of population dynamics in creating conflict depends on the presence of such social and political conditions. Population pressure has clearly accelerated a process that has been dormant for some time. It also reduced the system's ability to *adapt* effectively in the face of change.

Water is the second renewable resource that interacts with population dynamics to produce the potential for conflict and violence. The example from the Middle East mentioned in **HBR** illustrates how national and international forces combine with resource scarcity and population dynamics to produce conflict and violence. The Middle East is an area where the situation of water scarcity is critical, and could only get worse in the future. The potential for political discord is significant. In the Middle East, water scarcity is combined with some of the highest rates of population growth in the world through high rates of natural population increase or excessive net immigration.[6] The region is also characterized by increasing cropland scarcity, unequal distribution of resource endowments, imbalances in the distribution of military power, and the presence of unstable political regimes. This is a situation where a minor incident could trigger a chain of events that would lead to unpredictable outcomes. The case of Israel and the occupied territories discussed by **HBR** illustrates these dynamics. Indeed, concerns over access to water resources preceded the 1967 Arab-Israeli war and contributed to earlier tensions. The 1967 war, however, gave Israel control over most of the Jordan Basin's water resources. This control and the pattern of its utilization created non-sustainable imbalances between the supply and demand for water among the population groups living around the Jordan Basin that include those of Israel, Jordan, Lebanon, Palestine and Syria.

The situation is best illustrated by Miriam R. Lowi of Princeton University. She estimates that:

> "The average amount of renewable fresh water available annually to Israel is about 1,950 million cubic meters (mcm). Sixty percent comes from ground water, the rest from the river flow, floodwater and wastewater recycling. Current Israel demand -- including that of settlements in the occupied territories and the Golan Hights -- is about 2,200 mcm. The annual deficit of about 200 mcm is met by over-pumping aquifers. As a result the water table in some parts of Israel and the West Bank has been dropping significantly. Two of the three aquifers on which Israel depends lie for the most part under the West Bank, although their water drains into Israel. Thus, nearly 40 percent of the groundwater Israel uses originates in occupied territories". (Homer-Dixon Boutwell & Rathjens, 1993. p. 44).

The Israeli government introduced strict measures to limit the use of water resources in the West Bank. These measures were not equitable. According to the **HBR** study, the distribution of water resources was as follows:

> "Of the 650 mcm of all forms of water annually available there, Arabs are allowed to use only 125 mcm. Israel restricts the number of wells Arabs can drill in the territory. On a per capita basis, Jewish settlers consume about four times as much water as Arabs. Arabs are not permitted to drill new wells for agricultural purposes, although Mekorot (the Israeli water company) has drilled more than 30 for settlers" (Homer-Dixon, Boutwell & Rathjens, 1993, pp. 44-45).

Such severe inequalities in access to such a vital renewable resource could be a serious source of conflict and violence. However, given the comparative advantage of the Israeli military power, water shortages may create more intra-country conflict than inter-country "water wars." The situation is unstable and could destabilize further through the process of *population growth and its built-in momentum.* For example, because of the agricultural water policy, most of the Arab Palestinian population was forced to quit agriculture. They either became unemployed or sought jobs in Israel. The Palestinian population has a very young age structure. As a result, the rate of growth of population and the labor force will continue to increase at high rates at least for half a century, given reasonable assumptions about the future path of fertility. Non-agricultural labor absorption must accommodate the natural increase in the labor force as well as the forced exodus from the agricultural sector. If not, the excess labor supply will be a source of conflict either as emigrants or unemployed civilians.

The current peace process that is being initiated in the region includes an attempt to reach agreements on water use among all parties concerned. Such agreements should reduce short term tensions. Conflict, however, seems to be built-in the long term high rates of population growth, their momentum and the implied increase in water demand. It must be emphasized that future demand for water does not depend only on population growth. It depends equally on improvements in living standards and on the technology used in

agricultural and industrial production. These latter factors could also reduce the effective water supply by degrading water quality through increased waste and pollution. Commoner for example has found that the effect of technology on environmental degradation far exceeds that of population and per capita income growth rates combined. Commoner further concludes that direct control of the sources of pollutants has been more efficient in containing pollution levels than policies using indirect methods that rely primarily on market forces.

V. Conclusions

In this paper, the relation between population dynamics and conflict has been examined. The conclusions reached are based on conceptual analyses and empirical observations. The main conclusion of the paper is that population change has significant effects on social and political conflict; however, these effects are not direct. They exert their impact through other proximate factors such as increased scarcity of renewable resources, reduced economic productivity, migration expulsion, or the weakening of the state authority. Furthermore, the net effect of population change on conflict is not easy to assess. The effect of population change depends on the levels of other indirect factors such as inequality and the quantity and quality of existing resources.

An important corollary is that population change could create conditions that reduce the *adaptive capacity* of society. That last effect depends, among other things, on the *structure* of the social and political system. That *structure* includes, for example, the degree of society's ethnic and cultural homogeneity and the degree of equity in the distribution of income, opportunities and political power. Furthermore, the effect of population change on the adaptive capacity of society depends on the types of political and socio-economic institutions. The probability that conflict would be reduced is greater if such institutions were able to introduce necessary changes and, in the meantime, were able themselves to adjust to accommodate such changes.

The paper identified various mechanisms through which population change affects conflict. These are long-and short-term effects. It was emphasized that the long-term effects of population dynamics on conflict are the most serious. This is the case because the impact of long-term trends is not sudden but creeping. However, once the trend takes hold through the presence of a population momentum, it becomes difficult to contain or reverse. This argument is not novel. A similar example was given by Goldstone (1986), in which he argues that the factors that led to the English Revolution were:

> "...driven by the underlying force of population growth in the preceding century and a half. [Which] created a synergistic stress that caused the breakdown of the state power" Goldstone, (1986, p. 257-322).[7]

The long-term effects exert themselves through the influence of the shape of the age structure on the growth rates of population and the labor force. This built-in momentum creates conditions for system vulnerability, especially in poor countries with scarce renewable resources. It must be emphasized, however, that the built-in momentum of labor force growth is not necessarily a negative influence. It could be a source of future conflict, or alternatively, a facilitator for development. Whether society moves towards a costly conflict or towards sustainable development will depend on the success of its development efforts and how equitable its outcome. A continuation of high rates of population and labor force growth will generate *conditions* for violent conflict. Countries that postpone their fertility transitions will only increase the size of the momentum, increase its impact on system vulnerability and reduce the potential for sustainable development.

The short-term effects are mainly those of population movements. Population movements are initiated by the long-term interplay of population growth and resource scarcity. Large movements occur, however, as a result of sudden shocks when society reaches a state of system vulnerability. Population movements are equally sensitive to non-demographic forces. Relative deprivation as a result of economic inequalities within countries or across neighboring countries could result in large and sometimes unwelcome population movements leading to expulsion. Conflict is more likely to occur in situations that include ethnic, religious or racial minorities, and where inequalities are high and identified with these social groups.

A brief summary of the empirical findings follows:

1. In countries with extreme poverty and high cropland density, population movements may cross international boundaries. Serious conflict arises, especially in the presence of ethnic rivalry. This was the case of Bangladesh and Assam. The case also represents the situation of many Sub-Sahara African countries.

2. In countries with severe economic and political inequalities, conflict could arise even as the state attempts to remedy the negative consequences of long-term population growth. Such conflict could cross international boundaries. This was the case of Mauritania and Senegal. Population growth created resource scarcity. The elite who had political power were able to extract privileges. A process of costly ethnic violence erupted. The resolution of that short-term conflict did not deal with the basic underlying causes. There has been no serious effort to deal with the excessive rates of population growth. Neither resolved is the inequity of the political system that reduced the ability of the state to deal efficiently and equitably with such situations. The potential for future violence is very much alive.

3. Countries with joint claims on a critical renewable resource, such as water in the Jordan Basin, impose solutions based on relative military power. In the aforementioned case, these solutions did not give adequate regard to the needs of large segments of the population. When solutions are imposed based on ethnic or religious lines, the outcome is an unstable

system that serves as a breeding ground for conflict. The potential for future conflict increases when the populations concerned have a high growth momentum. The need for international mediation becomes essential. This is the Middle East case.

In our discussion of the Middle Eastern region, we only emphasized the potential role of population dynamics in creating conflict in the presence of renewable resource scarcities. We did not dwell on the role of oil politics and the associated international labor migration in the region, especially in the Gulf countries (Sirageldin, 1992). There seems to be a potential misreading of the directions of future events in the region that requires comments. The Economic and Social Commission of Western Asia (ESCWA), for example, predicted that the non-national labor force in the Gulf countries will continue to grow at the rate of three percent a year through the present century (ESCWA, 1992). Such scenarios have been used to predict future economic trends in the region, including external financial flows (e.g., Diwan, Squire & Underwood 1993). The analyses might be valid in the immediate term. As the discussion of the present paper illustrates, 'longer-term trends and prospects' must deal simultaneously with the interaction of population momentum and resource scarcity, and the ability of the social and political structure to accommodate these fundamental changes. The economic and social consequences of the built-in population momentum in both the labor receiving and sending countries must be considered in projecting future flows. In a recent comparative analysis of the political economy of Egypt and Turkey during the period 1950-1985, Hansen (1991, p. XV) shows convincingly that:

> "...development in both countries have been too complex to permit simplistic inference and conclusions about causes and effect of poverty, equity and growth"

However, Hansen finds some significant differences between the two countries that explain observed differences in the path of their agricultural development. Agriculture grew in Turkey but not in Egypt during the analysis period, mainly because Turkey was able to expand the extensive margin of land until about 1960, whereas Egypt had reached this point by 1900. The importance of relating the growth momentum of the labor force to resource scarcities needs no emphasis. However, that momentum seems underutilized in the Diwan, Squire & Underwood (1993) analysis of trends and consequences of migration flows in the region. To illustrate, the growth of the native labor force in Saudi Arabia and other Gulf countries is about 3.5 percent per year. Because of the built-in population momentum, this rate will continue to increase for the next forty years at least. The result is a fourfold increase in the size of the national labor force in these countries. The evaluation of such a prospect should be the basis for the analysis of longer-term trends and consequences of migration flows. The *potential* for future conflict is already built into the present socio-demographic system. Present analyses and policies should anticipate the consequences of such built-in demographic momentum, especially as it interacts with the resource base. Goldstone's (1986)

analysis is illustrative of such historic consequences.

In summary, the discussion indicates that the effect of population change on violence depends on the existing socioeconomic and political structure. But the strength and ability of the state to manage also depends on that same structure. Most of the literature on conflict focuses on the short-term manifestation of population change, such as population movement. Forecasting the future, however, requires a careful look into the shape of the age structure and long-term population dynamics. Almost all of the populations of the developing world have a young age structure with a high momentum for growth, especially its labor force. Disparities between the future supply and demand for labor could generate processes leading to serious conflict. However, attempts to increase the demand for labor could be self-defeating if they lead to over-consumption, severe socio-economic disparities, or excessive population growth relative to resource formation. The outcome of such efforts is resource scarcity leading to a state of system vulnerability where reaction to immediate crises consumes the bulk of government concerns and resources.

National and international agencies should focus on long-term strategies that promote efficient and equitable development, and that seriously reduce fertility. This concern with long-term developmental direction and vision is most needed but least evident when society reaches a state of system vulnerability. This is illustrated in the context of the population dynamics' basis for a sustainable agricultural transformation in Egypt as follows:

> "The problem is that in Egypt the short-term issues (crises) have taken precedence. The success of the policies adopted is a matter of survival. Indeed, all governments are concerned about balancing political stability, equity, and efficient utilization of resources. However, sustainability is an issue of intergenerational equity, and *attempting to buy political stability today at the expense of instability tomorrow is not a sustainable strategy"* (Sirageldin, 1993, p.228).

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NOTES

[1] For more details about the demographic transition, and an explanation of demographic concepts, see the World Bank (1984), and the World Bank (1993) for the health transition.

[2] It is somewhat puzzling that models of household behavior continue to be formulated in the neoclassical tradition of assuming a purely competitive market with a perfect clearing mechanism, while recent developments in other areas of 'hard-core' economic analyses question whether markets are the best institutions available? See for example, Allen & Gole (1994).

[3] For a technical statement about momentum that proves that the population under 30 does not change significantly in size, see Young, Schoen and Sarma, 1991).

[4] For a heroic attempt to present a complete and coherent Islamic economic system based on an axiomatic approach, see Naqvi (1994) and the paper by Sirageldin on "Islam, Society and Economic Policy" in this volume..

[5] In 1991, in an interview on the United States National Broadcasting Radio (NBR), Milton Friedman stated that democratic participation often leads to more privileges for labor unions and to more demands for elaborate systems of social security that distort market behavior. Such distortion will eventually lead to inefficient resources allocation and loss of total welfare. It is the rights of the market, Friedman argued, rather than democratic participation that should be guarded.

[6] The present discussion is illustrative of a large and complex subject. In a recent literature review, Watson (1994) lists over 160 studies that deal with the socio-economic and political aspects of water policies in the Jordan Basin region alone.

[7] This reference was brought to my attention by Carol Underwood of the Johns Hopkins University.

Lifestyle and technology: How much difference can they make?

Submitted by
Faye Duchin

Lifestyle and technology: How much difference can they make?

Faye Duchin[1]

Abstract

Over the centuries the question, "How many people can the earth support?" has generated a wide range of answers, each reflecting the concerns and assumptions of the analyst and the state of knowledge of the times. Today's concerns are about the ability of the environment to furnish resources for an unprecedentedly large, materialistic, and technologically sophisticated human population, without intolerable degradation in response to the pressures placed on it.

This paper describes a line of inquiry that can provide insight into social, economic, and environmental interactions as a basis for helping to avoid undesirable outcomes and pursue promising ones. First we establish that the recommendations of the Brundtland Report (which popularized "sustainable development" as a definable objective), contrary to the report's intentions and claims, would put increasing pressure on the environment over the next several decades. Based on this conclusion, we argue that: (1) There are two areas in which changes can actually be made, the choice of technology in production facilities and the lifestyle choices of different kinds of households. (2) It is unrealistic to expect a scientific analysis to tell us what should be done or what will happen -- or even to "bracket" what is likely to happen -- in the future. Thus we do not try to answer the opening question directly. Instead, if we are able to provide alternative visions (or strategies or scenarios) about changes in lifestyles and in technologies, an analytic framework can be useful in suggesting what the consequences of these changes might be. The paper sketches the conceptual and empirical framework of Structural Economics that can be used to carry out such an inquiry and proposes concepts and methods for meeting the next round of challenges.

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Introduction

1. Modern Lifestyles and Technologies

We ask the question "How Many People Can the Earth Support?" out of curiosity about human life on our planet, but it also reflects apprehension that there may be unpleasant consequences if critical thresholds exist and are crossed. The repercussions could entail positive feedback between irreversible impoverishment of the natural world and large-scale social distress and violence.

There are more people alive today than in any earlier period and a larger proportion lives in material affluence (by any measure). Contemporary technologies -- such as those for extending life or extracting materials from the environment and transforming them -- are unprecedented in their power to alter nature and to make existing technologies obsolete. The combination of these forces has had a noticeable impact on water, land, and air and has expanded the habitat appropriated by humans at the expense of other forms of life.

Such social and environmental pressures are magnified by the global appeal of trying to copy one particular lifestyle -- the affluent way of life pioneered in the urbanized western democracies -- which involves an explosion in the volume and variety of goods and services that are produced for sale. Following the apparent failures of socialism and "third ways," such as those of Gandhi and Nyerere ("self-reliance" in Tanzania), this is now seen as the virtually unique path to progress. The dominance of this model of economic development reflects a massive influence on lifestyle aspirations along with a transfer of technology from rich to poor countries. It explicitly entails the adoption of social values and institutions developed in market economies by both formerly communist and non-industrialized, agrarian societies. Pressures for entering first the monetized economy and then the global economic system are felt at all levels, from villages to national governments. As an instance of the latter, the World Trade Organization is now hearing proposals to extend its promotion of free trade in goods and services to the liberalization of foreign direct investments.

The demonstration effect, whereby the dominant technologies, lifestyles, institutions, and values of the rich, market countries are emulated in other places, is convenient for both the originators and the imitators. For the originators, these ways are familiar and predictable. For the imitators, they seem like a proven formula for modernity and success. The transfer process is accelerating because higher rates of return on investments in faster-growing economies of the developing world attract the profits earned in the developed countries.

The pursuit of what I will call (with apologies to Europe and Japan) American lifestyles and technologies is deeply rooted and it conveys many benefits. Nonetheless, undesirable, unintended consequences are clearly observable in the form of characteristic social and environmental problems in rapidly industrializing countries (not to mention the characteristic problems of the rich countries themselves), as well as truly global ones. It is

against this backdrop of the growing dominance of American lifestyles and technologies that we must situate the question, "How many people can the earth support?"

2. What Are the Alternatives?

While there are many utopian visions about an egalitarian future, I have never heard it suggested that all the people on the planet could live like affluent Americans. At the other extreme, there are plausible scenarios that most people would consider highly undesirable. One can imagine, for example, the rich living (at least for awhile) in "bubbles of richness" (Gallopin, 1993, p. 10), separated from wretched droves by walls, closed country boundaries, police and armies, and provided with clean air, water and other necessities by purification plants of all descriptions. Gated communities, immigration pressures, and bottled water provide a foretaste.

An equally plausible but much more reassuring outlook was provided by the Brundtland Report, Our Common Future, a widely cited document drafted by a committee of prominent individuals representing all corners of the world. In this view, increased affluence based on economic growth is necessary for rich and poor alike and can be achieved by adopting clean, modern technologies which simultaneously lower costs and reduce waste and environmental degradation. According to the authors, the political commitment to "manage and improve" technology and social organization can lead the way to a new era of economic growth and sustainable development (World Commission on Environment and Development, 1987, pp. 8-9).

Even if such outcomes could be reached by the kinds of means discussed in the report, they might be difficult to achieve politically. But if they are not even physically feasible, the political commitment to them could not succeed. In this case it would be wrong-headed because it would obstruct the search for other solutions by providing a false sense of security.

My colleagues and I were asked to analyze whether or not the technical means described in the Brundtland Report could achieve the stated objectives. To do this, we made use of a model and database of the world economy, detailed in coverage but of simple structure, that has been implemented with support over the years from the United Nations. We compiled a description of production and consumption in all parts of the world economy, focusing in particular on the use of energy and materials. Methods were developed to describe the present technologies in electric power generation, industrial energy use, the processing and fabrication of metals, construction activities, household uses of energy, and the production of cement, pulp and paper, and motor vehicles. The technical literature provided the basis for this description and for scenarios about specific changes in technology and organization that could be anticipated in different regions over the next several decades. The scenarios follow the Brundtland Report in leaning toward assumptions that are optimistic

in terms of increased efficiency and reduced environmental degradation, such as high rates of recycling of materials (Duchin and Lange, 1994).

Our results suggest that modern, clean technologies and conservation practices can economize substantially on materials and energy and can, on balance, reduce costs of production.

But their ability to reduce pollution relative to today's practices cannot offset the effects of increases in population and material standards of living: the pollutant emissions that we examined all increase over the next several decades. The Brundtland Report was and still is important for its portrayal of the scope and interconnectedness of many social and environmental problems on a global scale. However, its recommendations do not provide an adequate basis for realistic national and cross-national policies.

Thus, we can expect that over the next several decades our numbers will increase by several billion people and they will live, on average, in an environment that is more rather than less degraded than today. If we hope to prevent such an outcome, we need to envisage much bolder departures from present practices and trends in terms of both lifestyles and technologies.

The rich countries may need to adopt, and transfer, different kinds of lifestyles and technologies that are more benign. They could encourage experimentation in developing countries with approaches outside of the dominant trends by systematically reducing rather than intensifying pressures to copy the "American" patterns.

These suggestions run counter to some deeply held convictions, however: that society has one specific objective (or a small number of them) and that there is one uniquely "optimal" solution for achieving it, that state-of-the-art technologies are more profitable than ones of earlier vintage, that more profitable options will and should always be selected over less profitable ones, and that all rational people when they act on their own account are consumption maximizers.

On closer inspection, of course, each of these convictions is seen to be highly stylized. But the fundamental challenge, more fruitful than criticizing these idealized notions individually or jointly, is to describe concrete technological and lifestyle alternatives that are demonstrably superior in specific contexts. In the area of technology, there is a history of considering alternatives and several new kinds of efforts are under way. However, there is far less experience in describing lifestyles in a systematic and concrete way, let alone in conceiving of potentially attractive alternatives to mainstream affluent lifestyles.

3. The Research Challenge: Constructing and Analyzing Alternative Scenarios

There is no definitive answer to the question "How Many People Can the Earth Support?" It depends on where and how they live and on the state of natural systems. For most of our time on the planet, people lived as hunter-gatherers, but it might well be hard for even a small

population to survive in this lifestyle in the aftermath of a global industrial society (Gowdy, 1994). Assuming that the human population will increase and perhaps double over the next 50 to 100 years, how could we do better than attempting to follow the prescriptions of the Brundtland Report?

There are a number of approaches to alternative technologies that represent substantial departures from today's so-called best practices. "Appropriate technology" (Schumacher, 1973) is one important strand. Its proponents argue that techniques and tools must be chosen in the context of the social system in which they are employed. In this view, labor-intensive approaches and simple technologies based on local production, whether of traditional design or newly-created, are well-suited to the situation in most developing countries. Florman (1981), an engineer who recognizes what he calls the danger of these views, rebuts them on social as well as technical and economic grounds , in a way that is incisive but too readily dismissive in general of a proposition that needs to be examined in specific contexts. If the idea of appropriateness could replace that of unique solutions, Schumacher could have the following among engineers that will be necessary for the implementation of his ideas.

Industrial Ecology (see, for example, Allenby and Richards, 1994) is a new approach to engineering design that is supported by parts of the engineering profession and the manufacturing community. The guiding ideas are a life-cycle perspective and the attempt to "close the loops" in the use of energy and especially materials. Design objectives include not only physical properties and economy, but also durability, recyclability, and disposability. The objectives of Industrial Ecology have been described in general terms as decarbonization of the energy system and dematerialization of production, but the work that has been done to date within this framework focuses mainly on innovations that are cost-saving for manufacturers but relatively modest in their overall impact.

Several scenarios which would substantially reduce net carbon emissions from combustion represent large departures from current practices. One is an energy system that operates on photovoltaics and hydrogen fuel (Rogner, 1996), and another is the large-scale production of biomass for fuel (Williams, 1994). A case has also been made for the widespread use of biomass for industrial materials (Morris and Ahmed, 1992). Two ambitious approaches, which have been successfully implemented in many settings by their inventors, are the "living machines" of John Todd (1991; Todd & Josephson, 1995), ecosystems designed for remediation of polluted bodies of water or for sewage treatment, and "permaculture," the customized systems of intensive agriculture designed by Bill Mollison (1988). These practical, highly creative lines of thinking and action provide the raw material for building alternative scenarios.

By contrast, practically no systematic work has been done about lifestyle. Consequently, while any engineer could name dozens of technologies, economists would have difficulty distinguishing even a few lifestyles. The starting point needs to be a classification

of household types in a given society according to common patterns of work, leisure, consumption, attitudes, and the values of its members (Duchin, 1995). The kind of classification that is needed has been developed not by social scientists but by market researchers who describe American lifestyles in terms of several dozen categories, including for example Gray Power, Black Enterprise, and Blue-Collar Nursery (PRIZM system, Claritas Corporation; tabulated in Weiss, 1988). While the market researchers are interested in niche markets for beers or magazines, our challenge is to define a set of activities for each group of households, or lifestyle, describe how the activities are carried out, and then develop alternatives. One activity, for example, is recreation, which could involve vacation travel by air, purchase of specialized electronic or sports equipment, or hiking near home. The provision of food can involve eating out, purchase of products that are highly processed and heavily packaged, or a diet of mainly grains, tubers, and vegetables. An analysis of lifestyles in terms of activities is directly analogous with a "process analysis" of industrial production.

This effort needs to combine the systematic, comprehensive, and quantitative coverage of the social accounting tradition among economists (for a review, see Duchin and Lange, 1995) with the empirical content that can be provided by anthropologists, sociologists, and other social scientists. My colleagues and I are in the early stages of this kind of work in several developing countries (Dominican Republic, Namibia, and Indonesia). Each society presents unique challenges for even the first step, the classification of households. A number of such studies need to be carried out before generalizable concepts and methods can be identified.

Because the framework is in such an early stage, I can only hint at what will be involved in describing possible alternatives to today's lifestyles. Central themes will no doubt be the trade-off between time spent at work and leisure time, and how leisure time is spent. These decisions in turn depend upon attitudes toward nature and the existence of public places, such as neighborhood centers for youth and the elderly. Important decisions related to mobility and the choice of transport are directly dependent on how communities are physically laid out and the convenience of public transport.

On the basis of these kinds of work, one will be able to construct qualitatively new scenarios about lifestyles and technology. Then selected scenarios need to be analyzed, such as we have analyzed the scenario implicit in the Brundtland Report, to determine order of magnitude estimates of their physical implications. For a subset of the scenarios, it will be interesting to proceed further and assess the costs, prices, economic incentives and regulations that might be associated with them.

Building such scenarios and analyzing them is as much art as science, as much a qualitative as a quantitative challenge and one that crosses disciplinary borders. In essence we need to create a set of stories around different kinds of possibilities, like a historian of the

future. Hopefully, some will capture the public imagination the way protection of the environment did.

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Population, Development and Global Warming
The International Institutional Challenges Ahead

Submitted by
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Population, Development and Global Warming: The International Institutional Challenges Ahead

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Abstract

Carbon emissions from fossil fuel use and other human activity are predicted to cause a significant warming of the global climate, according to a growing consensus of scientists. Global warming would have substantial negative effects on the world environment and economy. Human population and economic growth continue to drive both energy use and carbon emissions. While the developed countries are the largest source of present and past emissions, developing countries are rapidly catching up. China will probably surpass the United States as the largest carbon emitter early in the next century. The global warming treaty signed in Rio in 1992 relies entirely on voluntary emission caps for developed countries and has had little or no apparent effect on emissions. Much stronger steps must be taken to avoid or lessen potential climate change. A globally determined but nationally imposed carbon tax should be adopted to internalize the future costs of carbon emissions into the present cost of fossil fuel and other carbon sources. This would allow the maximum use of free market forces and individual choice to determine how carbon emission reductions are achieved. In addition, national emission caps for all countries should be established. International trade mechanisms can be used to support universal implementation of these measures. Where possible, global warming policy should include strong but equitable incentives for sustainable development and population stabilization, important goals in themselves regardless of the extent of future climate change.

I. Introduction

There is growing scientific agreement that human activity is causing a significant warming of the global climate, primarily through carbon emissions from the combustion of fossil fuels. The Intergovernmental Panel on Climate Change (IPCC), a U.N. sponsored group of 1000 scientists and reviewers now predicts a global temperature rise of 1 to 3.5 degrees Celsius by the year 2100, with major potential effects on sea level, precipitation patterns, weather, agriculture and biodiversity (IPCC 1995). Scientists, governments and international institutions have recognized the need to minimize the level of global warming, through the 1992 United Nations Framework Convention on Climate Change (or Rio Treaty) and unilateral measures within a few countries. Nonetheless, the pace of carbon emissions has

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continued virtually unabated since the Rio Earth Summit. Human population increases continue to drive economic growth, energy use and carbon emissions.

The voluntary limits of the Rio Treaty currently apply only to developed countries. As of 1996, it seems very unlikely that the target of reducing carbon dioxide to 1990 levels in the developed countries by the year 2000 will be achieved. At the same time, fossil fuel use and resultant carbon dioxide release have been increasing dramatically in the developing world. In 1995, total carbon dioxide emissions of the western industrialized countries roughly equaled those of the developing world and former eastern bloc nations combined, but the relative share of the developing world is projected to increase substantially. Looking into the twenty-first century, it is apparent that the level of carbon emissions and global warming will be a function of the population and development trajectories of a wide group of countries.

Multi-lateral mechanisms such as the Rio Treaty should therefore be given more teeth and applied evenly to all sources of carbon emissions. In addition, a globally determined but nationally imposed carbon tax should be adopted, which would internalize the costs of carbon emissions and create strong economic incentives for maximum energy efficiency. International trade agreements could also be re-designed to support universal and equitable application of a carbon tax. Where possible, these measures should be structured in ways that allow the maximum use of free market forces and create strong national and international incentives for population stabilization and sustainable development.

Where the term "carbon emissions" is used in this paper, it refers to all sources of carbon. However, this paper will focus primarily on fossil fuel emissions, with the recognition that deforestation and changes in land use are also significant anthropogenic contributions to global carbon emissions. This paper will not deal extensively with chlorofluorocarbons (CFCs), which are now regulated by the Montreal Protocol.

II. The global warming prognosis

In the fall of 1995, the U.N. sponsored Intergovernmental Panel on Climate Change (IPCC) released a report prepared by a team of 1,000 scientists and reviewers, which concluded that "the balance of evidence suggests that there is a discernible human influence on global climate." (Kerr 1995a). The new IPCC climate model now incorporates both rises in greenhouse gases and the countervailing "aerosol" particulate cooling effect, a significant advance from earlier models (IPCC 1995, IPCC 1990a, Kerr 1995c, Bolin 1994). Assuming the "best estimate" value of climate sensitivity and a mid-range emission scenario, the model projects an increase in the global mean surface temperature of 2 degrees Celsius from 1990 to 2100, with a potential range of 1 to 3.5 degrees of warming by 2100 (IPCC 1995). The global temperature has already increased by about 0.5 degrees since the late nineteenth century, according to the IPCC and several other scientific groups (MacCracken 1995, Kerr 1996).

In all IPCC scenarios, the rate of warming over the next century would likely be greater than any seen in the last 10,000 years (IPCC 1995). Because of the thermal inertia of the oceans, the global temperature would continue to rise substantially after the year 2100, even if concentrations of greenhouse gases were stabilized by 2100. As a result of thermal expansion of the oceans and melting of glaciers and ice-sheets, the IPCC "best estimate" model projects a rise in sea level of about half a meter by 2100, with a range of 15-95 centimeters, given all combinations of emissions and climate sensitivity (IPCC 1995).

A one meter sea level rise would flood 17% of the total land area of Bangladesh, 12-15% of the arable land in Egypt, and major river deltas in the United States, China, Pakistan, Brazil, Argentina, Nigeria and other countries. Many island countries would suffer severe losses of agricultural and residential land (IPCC 1990). Other potential impacts include increased flooding, coastal erosion, and salinization of coastal cropland and aquifers (Titus 1989). A net global forest loss of 3.7% in biomass (5.8% in area) may occur because of temperature and precipitation changes, with even larger losses during the transition (Sedjo and Solomon 1989).

Species extinctions may potentially be the largest loss from global warming, although they are very difficult to quantify (EPA 1989, Cline 1992a). Habitats, ranges and community relationships of plants and animals could be altered dramatically in a few decades, beyond the ability of many species to adapt or migrate. These effects would be exacerbated by anthropogenic barriers and fragmentation of habitat. In marine zones, ocean warming, bleaching of coral reefs, inundation of estuaries, and alteration of ocean currents are also expected to cause substantial extinctions (Titus 1989, Norse 1996).

Predictions for economic losses due to global warming vary widely but could be on the order of 5% per year of GDP (Winters 1992), though it is virtually impossible to calculate the complex set of indirect effects that climate change would have on national economies and the world market. Potential annual agricultural losses have been estimated at roughly 7% of world production, or $40 billion (Cline 1992b). In the United States alone, the annual cost of forest loss and sea-level rise could be $4 billion and $10.6 billion, respectively (Cline 1992b). Countries with heavily populated or agriculturally developed coastlines would suffer the most, along with nations and people that depend on marginal land, where small differences in temperature or precipitation may greatly affect agricultural fertility (Repetto 1994, IPCC 1990b). Agricultural effects may be of particular concern because global per capita grain production has been flat or slightly falling over the last two decades (USDA 1993, Brown et al. 1994).

The adverse effects of global warming are predicted to affect all parts of the world (Kerr 1995a). Regional impacts will probably vary, and agricultural prospects may even improve in some locations, but it is expected that most countries, whether industrialized or developing, would experience serious human health, economic, social and environmental

problems and dislocations. The ranges of vector-borne diseases, such as malaria, yellow fever and dengue fever are likely to increase (IPCC 1995). While effects may be roughly evenly spread on a global basis, capacity to respond is not. Countries with high population densities and/or less developed economies may be more poorly equipped to navigate warming effects such as rising sea level, shifting agricultural productivity, and variances in amounts, distribution and intensity of precipitation (IPCC 1995, Kerr 1995a, Keyfitz 1992).

There is a long time lag between anthropogenic emissions and actual global warming, and the effects are not considered to be reversible in any politically relevant time scale. Greenhouse gases added to the atmosphere today will therefore continue to have a warming effect on the global climate for more than a century and probably several hundred years (Houghton 1992). Therefore, emissions policy over the next few decades will have an impact on several future generations of human beings.

III. Greenhouse Gas Sources: Past, Present and Future

Several gases contribute to the global warming process, including CO_2 (carbon dioxide), CH_4 (methane), CFCs (chlorofluorocarbons) and N_2O (nitrous oxide). The Intergovernmental Panel on Climate Change (IPCC) has calculated that the contributions to climate change of these gases during the 1980s were as follows: CO_2 (56%), CFCs (24%), CH_4 (15%) and N_2O (5%) (IPCC 1991).

From 1980 to 1990, the estimated relative contributions of greenhouse gases from human activities were as follows: energy (46%), CFCs (24%), forestry (18%), agriculture (9%), and cement manufacturing and landfills (3%) (IPCC 1991). As mentioned in the introduction, this paper focuses primarily on the energy (fossil fuels) sector, though reduction solutions could and should be applied to all carbon emission sources. On a per capita basis, carbon emissions in 1990 ranged from a high of 33.11 metric tons (United Arab Emirates) to only 0.03 (Nepal), a difference of more than three orders of magnitude (Engelman 1994). The global per capita average in 1990 was about 4.2 metric tons.

Global carbon emissions from fossil fuel burning alone have increased from about 540 million tons in 1900 to 1.62 billion tons in 1950 and 5.904 billion tons in 1993 (Brown et al. 1994). Combustion of oil accounts for more than 40% of carbon emissions, followed by coal (approximately 40%) and natural gas (less than 20%) (Brown et al. 1994, Marland 1983).

The developed world is and has been the primary source of carbon emissions in the present and in the past century. The United States is by far the largest source, emitting nearly 1.4 billion tons in 1992 (Brown et al. 1994), with western Europe, "centrally planned Europe" and OECD Pacific also major contributors (IPCC 1991). In 1995, total carbon dioxide emissions of the western industrialized countries roughly equaled those of the developing world and former eastern bloc nations combined. However, emissions are growing at a much faster rate in the developing world, and particularly in the rapidly industrializing Asian

countries. For instance, in 1992, emissions in China, India and South Korea grew by 7%, 17% and 28%, respectively (Brown et al. 1994).

China will almost certainly become the largest source of carbon emissions early in the twenty-first century (Lii 1996, Brown et al. 1994). At present economic and energy use growth rates, China will double its share of global carbon emissions from 11% in 1990 to 22% in the year 2100 (Cline 1992a). China's economic growth over the last fifteen years has averaged 9.4% percent per year (Esty and Mendelsohn 1995). The number of motor vehicles increased from 1.6 million to 18.8 million from 1980 to 1992, and new car sales are expected to rise by 30% in the next year alone (Esty and Mendelsohn 1995, Tunali 1996). Similar extremely rapid growth of car sales and gasoline use is occurring in Thailand, South Korea, India, Mexico, Brazil and other countries (Tunali 1996).

The energy future of China also depends heavily on coal, which is the fossil fuel with the highest carbon emissions per unit of energy derived. China is already the world's largest producer and consumer of coal, burning more than one billion tons in 1993. Estimates suggest that China will consume 2.7-3.0 billion tons of coal by the year 2020, making China the world's largest source of carbon emissions at 1.7-1.9 billion tons, exceeding the United States estimate of 1.56 billion tons for 2020 (Esty and Mendelsohn 1995). India, the world's second most populous country, is also expected to rely heavily on its coal reserves in the future.

On a global scale, the relative share of carbon emissions between industrialized (including former eastern bloc) and developing nations is predicted to shift from 74% (industrialized)/26% (developing) in 1985 to 68%/32% in 2000 and 56%/44% in 2025 (World Resources Institute 1994).

IV. Population and Development Trajectories: Past and Future

The rise in carbon emissions is closely linked with both population increases and economic development. Between 1950 and 1993, world population increased from about 2.5 billion to 5.5 billion, an increase of 120% (World Resources Institute 1994). Over the same time period, the global economy expanded from 3.8 to 19.3 trillion (1987) dollars, an increase of 408%, and carbon emissions from fossil fuels increased from 1.62 to 5.904 billion tons, an increase of 264% (World Resources Institute 1994). Therefore, in rough terms, global carbon emissions between 1950 and 1990 expanded at a rate about twice that of population, and at a slower rate than economic growth.

More recently, since 1970, carbon dioxide emissions have expanded at a rate approximately equivalent to population growth (Engelman 1994). The only brief plateaus or slight down-turns in annual global carbon emissions have coincided almost exactly with the wide spread recessions of the early 1980s and 1990s, and the oil crisis of the middle 1970s (Brown et al. 1995).

New technology and gains in energy efficiency have and will continue to reduce carbon emissions from fossil fuel combustion per unit of usable energy derived, but there are limits to these reductions. On the other hand, as oil deposits run out, a global increase in coal consumption is likely, which will produce higher carbon emissions (Gilland 1995). Ultimately, the combustion of every carbon-based fuel necessarily releases carbon dioxide as a by-product, and the level of use of fossil fuels is closely associated with development or "affluence", both on an individual and country-by-country scale.

Human population is expected to increase to 8.3 billion by 2025 and 9.8 billion by 2050, according to the U.N. medium projection (United Nations 1994). Unless the global economy is successful in moving completely away from fossil fuels, which is highly unlikely in any time period relevant to climate change, population growth will be a major driving force behind increases in greenhouse gas emissions.

Borrowing and modifying the Ehrlich and Holdren/Commoner I = P x A x T equation, carbon emissions from fossil fuels can be thought of as a function of the same factors (Ehrlich and Holdren 1971, Commoner 1972, Ehrlich and Ehrlich 1990).

Carbon Emissions (C) = P x A x T

where P = human population, A = Affluence, expressed here as the amount of energy used per capita, and T = Technology, expressed here as the amount of carbon emissions per unit of energy. Note that the technology factor can be affected through changes in fuel efficiency or by substitution of higher, lower or non-carbon emitting energy sources.

The most effective carbon emission reduction policy would address all three factors — population, the level of energy use, and the amount or carbon emissions produced per unit of useful energy.

V. Current Climate Change Agreements

At the Rio Earth Summit in 1992, the Framework Convention on Climate Change (FCCC or Rio Treaty) was signed by representatives from most of the nations of the world. Its objective is "to achieve...stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate...within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure food production is not threatened and to enable economic development to proceed in a sustainable manner" (FCCC 1992). It further advises a precautionary principle, that "(w)here there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing (climate change mitigation) measures" (FCCC 1992). In the Rio treaty, the developed countries also agree to attempt to reduce carbon emissions to 1990 levels by the year 2000.

While its language is quite bold, the effect to date of the Rio treaty has arguably been virtually zero. The United States, the European Union and Canada have admitted that they will not reach the voluntary emission stabilization target for developed countries for the year 2000, given current trends (The Economist 1995a). Sweden, Finland and the Netherlands have unilaterally adopted carbon taxes, ranging from $1.50 to $62 per ton (Poterba 1992), but it is not clear that this will result in reaching the stabilization target for those countries. The U.K. and Germany are probably the only countries which will hold emissions to 1990 levels, because of the shut-down of coal-burning industries in eastern Germany after unification and the substitution of the North Sea oil for coal in Britain. Otherwise, year 2000 emissions of the rest of the developed country Rio signatories are projected to exceed 1990 levels by 5-30%.

In 1995, the Conference of the Parties (COP) of the Framework Convention on Climate Change (or Rio Treaty) met and produced a document known as the Berlin Mandate. It concluded, not surprisingly, that the commitments of the developed nations to reduce their level of emissions were inadequate (Blaustein 1995). An agreement was also reached to "set quantified limitation and reduction objectives within a specified time-frame, such as 2005, 2010 and 2020" for the developed countries (FCCC 1995).

Under the original 1992 Rio Treaty, developing countries were requested only to develop and make available "national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol (i.e., CFCs)" and to formulate "programmes containing measures to mitigate (and adapt to) climate change" (FCCC 1992). Effectively, no action is required or even strongly suggested of developing countries beyond data compilation. The 1995 Berlin Mandate re-affirms this lack of commitments for developing countries, although it does institute a voluntary pilot program for activities described as "activities implemented jointly" between developed and developing countries to reduce carbon emissions, or "joint implementation" (FCCC 1995, Esty 1994a). The net practical result of the Rio treaty on carbon emissions from either the developed or developing countries thus far seems to have been a continuation of business as usual. In the ongoing negotiations, countries have organized themselves into predictable interest groups, such as the oil-producing nations, which generally oppose policies that might lead to lower consumption. However, the parties will meet again in late 1996 to discuss further possible steps, including firm quotas and tradeable permits (Blaustein 1995).

Short term political issues like jobs, economic stimulation and tax reduction have overshadowed climate change in national politics in the developed countries, and developing countries have not yet been required to act. Uncertainty among climate scientists has also been an excuse for inaction (The Economist 1995b). In the United States, currently the largest producer of carbon emissions, there seems to be little political will to raise fuel prices through additional taxes or to mandate or otherwise promote increased fuel efficiency.

Gasoline prices remain at real levels only half of what they were fifteen years ago, and one third or less of what they are in most other countries, creating no economic incentive for efficient use.

Despite available technology, fuel efficiency of the United States vehicle fleet is stagnant. In 1980, roughly 80% of Americans drove cars and 20% drove more fuel-consumptive trucks, including pickups, vans and sport utility vehicles (Salpukas 1996). In 1995, the share of trucks had jumped to 43%, with large, low-gas mileage pick-ups showing the largest gains (Cobb 1996). The largest selling vehicle, car or truck, in the United States for the last 14 years has been the Ford F-150, which operates at an abysmal 13-17 miles per gallon (Schuon 1996). The Clean Air Act contains much less stringent fuel efficiency standards for trucks, vans and pick-ups than cars, an unnecessary loophole that has effectively more than doubled in size since 1980 and apparently remains open for purely political reasons. This loophole has in fact created an incentive for both consumers and car manufacturers to gravitate towards the high-powered, low-efficiency truck market.

The abandonment of the 55 mile per hour speed limit by the federal government and all but a handful of U.S. states has further increased fuel consumption. A consumer group recently calculated that a car loses 18 percent of its gas mileage when it increases from 55 m.p.h. to 65, and 33% if its speed increases from 55 to 75 (Salpukas 1996). The net result of these factors is that gasoline consumption in the United States has increased at an average annual rate of 1.7% since 1992 and is expected to rise by 2% or more per year for the next five years (Salpukas 1996). This increase, it would appear, is primarily driven by low gasoline prices, higher highway speeds and a fleet of vehicles increasingly dominated by trucks and sport utility vehicles.

In other words, the increase of fuel consumption and carbon emissions in the United States is the result of a political rather than technological failure. This is unfortunate since the United States will have to be a leader in any carbon emission reduction plan, both because it is the largest source and because it is doubtful that many other countries will follow suit without the U.S. leading the way (Crane 1992). The U.S. government now estimates that it may fail to meet the Rio Treaty emission caps by at least 5%, and even more if climate change funding is cut by the U.S. Congress as expected. To put that failure into perspective, a 5% increase in U.S. 1990-level carbon emissions is equal to 300% of Egypt's total emissions in 1990, 122% of Brazil's emissions, or 36% of India's emissions (derived from Engelman 1994).

As discussed earlier, carbon emissions from the developing world are rising even more rapidly than in the developed world, increasing by more than 50% in the last decade (Brown et al. 1995). Global emissions plateaued briefly in the early nineties, solely because the massive recession in the eastern bloc countries offset the economic boom in parts of the developing world. With the end of the eastern bloc downturn, world emissions are expected

to resume their rise. Thus far, there has been little or no redirection of international energy policy to take account of global warming (Boehmer-Christiansen 1994).

In conclusion, while the Rio Treaty was laudable step, it is clear that much stronger action is necessary to achieve actual carbon emission reductions. The FCCC may be a viable forum for such action, but the past and present strongly suggest that measures such as voluntary carbon emission caps are likely to be ineffective. Moreover, if limits apply only to the developed countries, no net reduction in greenhouse gases is likely, given growth trajectories for the developing world. Within fifty years, China and India, with rapidly expanding economies and large deposits of high carbon emission coal may dwarf developed world greenhouse gas output. At this point in history, climate change is best addressed globally, or at least multilaterally among the major carbon emitters, whether developed or developing.

VI. Global Warming Solutions: Quotas, Tradeable Permits, Carbon Taxes and International Trade Agreements

Climate change is a truly global problem, caused by many essential human activities in all countries, and its effects will cause harm to most or all people and countries, regardless of the source of the emissions. No individual country is a sufficiently important source of carbon emissions to unilaterally affect the rate of global warming significantly (Poterba 1992). Nor can the problem be accurately characterized as a North/South or developed vs. developing countries issue. Past dominance in energy use and carbon emissions on the part of developed countries is being quickly erased by higher population growth and rapid economic and energy use growth in a number of large developing countries.

Therefore, there exists at least the potential for negotiating an equitable global solution. While the 1992 Rio Climate Convention sensibly placed an early focus on carbon emission reduction agreements on the part of the developed world, effective future solutions must obviously include the entire world, and particularly China and other countries with rapidly developing economies who will inevitably be major sources of carbon emissions in the future.

While substantial future combustion of fossil fuels and release of carbon emissions is inevitable, the quantity of future emissions could be greatly affected by policy decisions. Six scenarios developed by the IPCC in 1992 project that annual CO_2 emissions could potentially vary from 4.6 to 35.8 GtC (Gigatons of carbon) in the year 2000, depending on levels of population, economic and energy use growth (Houghton et al. 1992). The variance in climatic impacts of these different emission scenarios would be enormous.

In its 1991 report, the IPCC considered several implementation mechanisms, specifically public education and information; technology development and transfer; economic (market) incentives; financial incentives; and legal and institutional mechanisms (IPCC 1991). While all of these may contribute to reduction or limitation of carbon emissions, the following

discussion will focus on economic, legal and institutional mechanisms, particularly tradeable permits and carbon taxes, with specific reference to the interactions between population and development. Under any policy aimed at limiting or reducing global carbon emissions, human population growth will be a significant factor, whether implicitly or explicitly, since total emissions are a function of per capita output multiplied by the number of people.

At least two general approaches are available. The first approach would be to hold each country to a specific cap (i.e. based on a percentage of 1990 emissions) and allow trading of emission "permits." Alternatively, the global emission target could be achieved by economic incentives (i.e. carbon taxes), which would involve raising the level of taxation globally until fossil fuel use, etc. were suppressed to the desired level of emissions.

Tradeable Permits

Tradeable permits, or transferable emission rights, would allocate quotas to countries to emit carbon into the atmosphere. The global carbon budget would be set by international agreement, and countries could use their individual quotas or sell them to other countries. Theoretically, the global market would then ensure that the most cost-efficient carbon-emission reduction steps were taken first. This melding of free market principles and environmentalism has been quite successful inside the United States (Esty 1994a), but could be more tricky on an international scale.

One serious problem may be how to allocate quotas among countries. If quotas were allocated on the basis of present population size, the industrialized nations would have to pay large fees to developing countries in order to maintain their high current levels of carbon emissions (Carliner 1995). If these quotas were further adjusted for future increases in population, the system would actually create a perverse incentive for high population growth and penalize countries with low, zero or negative population growth, since a country's carbon emissions quota would be based on its percentage of global population. If, on the other hand, quotas were allocated on the basis of current emissions, as now occurs with some air pollutants such as sulfur dioxide among industries in the United States, developing countries with rapidly growing economies and emissions would be faced with huge payments to the industrialized countries in the future.

It is hard to imagine that either of these quota allocation mechanisms would be politically acceptable, because they do not adequately balance current and future levels of development and population, and they might require huge capital flows between countries. The international community is currently debating whether to strengthen the Rio Treaty through the use of "joint implementation," under which developed countries may meet some of their own carbon emission reduction goals by funding emissions-reductions projects in developing countries, where costs may be lower (FCCC 1995). It is still unclear how joint implementation would fit into a truly global carbon emissions scheme.

A variant of the tradeable permit concept is the "tradeable adsorption option," under which individual energy suppliers would be required to adsorb part of the carbon emitted when the fuel is burned by the customer (Read 1994). It would be designed to encourage energy suppliers to grow trees, pay a third party to grow trees, or pay a third party to install efficient technology to reduce carbon emissions. While retaining the free market aspects of tradeable permits, the tradeable adsorption option also would effectively internalize the cost of carbon emissions into the price of energy, since energy suppliers would pass on the expense of carbon emission reductions to energy purchasers. Its other advantage over a national quota system would be that economic decisions would be made on a more local scale and presumably more efficiently. However, tradeable adsorption options do not actually cap emissions directly, and adsorption may be difficult to monitor, verify or enforce.

Carbon taxes

The IPCC has suggested that a tax on fossil fuels, levied in relation to carbon emissions, could be efficient and effective if its level were the same across all countries and it were applied evenly to all fossil fuels (IPCC 1991). Herman Daly (1996) has also suggested a similar proposition, which he refers to as the taxation of "through-put." A carbon tax would be levied on the amount of carbon emitted, so that natural gas would be the least taxed per unit of energy output, followed by oil, and coal, the "dirtiest" fuel, would have the highest tax per unit of energy output (Herber and Raga 1995). The carbon tax therefore is designed to equitably internalize the "external" carbon emission costs into the price of fossil fuels. While most discussions of a carbon tax focus solely on fossil fuels, it may be more appropriate to include all sources, including agriculture, forestry and industry (Stewart and Wiener 1990).

Poterba (1992) points out that a carbon tax large enough to significantly reduce use and emissions would generate a large amount of revenue, perhaps several percent of an industrialized nation's GNP. It is unlikely that any country would be willing to surrender revenues of that magnitude to an international organization. Therefore, domestic carbon taxes, imposed unilaterally at levels agreed to multilaterally, and perhaps regulated or overseen by an international organization, are a more likely scenario. It has also been suggested that part (perhaps 10%) of these taxes could be re-distributed to developing countries willing to limit or reverse deforestation losses and increase fossil fuel efficiency (Cline 1992a).

Increased efforts to restrain population growth are also likely to be part of any global bargain. Cline (1992b) estimates that given a mid-21st century population of 10 billion, an annual global carbon budget of 4 GtC, and an intermediate carbon tax of $175 per ton, family planning programs would be worth $1,000 to $3,000 per birth permanently avoided. Therefore, one appropriate use for carbon tax revenues would be to finance or improve family planning programs and other efforts which indirectly may have lead to lower population

growth.

Within particular countries, it is not necessarily true that a carbon tax and therefore higher fossil fuel prices would lead to deleterious economic effects or higher overall taxes. The tax burden could be simply shifted from income, sales and other taxes to carbon taxes. Higher energy prices would also provide incentives for greater efficiency. The first 20-25% of this efficiency gain might be achieved at zero or negative cost, because the cost of energy efficiency improvements would actually be lower than the increase in fuel prices (Cline 1992a, OTA 1991). Users would also be economically encouraged to substitute lower or zero carbon emission energy sources such as solar power, hydro-electricity or biomass for existing coal, oil and gas. Elimination of existing subsidies, which cause inefficient use, could substantially cut global carbon emissions by as much as 8% (Cline 1992a, World Resources Institute 1990).

A frequent objection to fuel taxes in general and carbon taxes in particular is that they are regressive, because low income households spend a significantly larger proportion of their income on fossil fuel for heating, cooking and transportation. A combination of income tax credits, transfers and other progressive counter-measures can be used to neutralize this effect (Poterba, p. 82-83). In addition, carbon tax revenues could be used to subsidize energy efficiency improvements and economic activity with lower carbon emission potential, or to offset otherwise undesirable carbon tax effects. Finally, when negative social, economic and environmental effects of global warming materialize, the tax revenues can be used to mitigate them.

Tax revenues from a carbon tax large enough to affect consumption would be substantial. For instance, a carbon tax of $100/ton of carbon would produce revenues equivalent to an estimated 1-5% of GDP (Winters 1992). A tax of this magnitude would be very high relative to the price of coal (256% of the estimated year 2000 producer price) and lower for natural gas (53%) and oil (49%) (CBO 1990, Cline 1992a). As with tradeable permits, the possibility of huge transfers of capital between countries presents a political barrier to acceptance and implementation of carbon taxes. The specter of a large international organization assessing and divvying carbon taxes on internationally traded fossil fuels is unlikely to play well in national politics in either the developed or developing world.

A more palatable design may be to determine appropriate carbon tax levels globally, but have them assessed by governments of individual countries (Herber and Raga 1995). To make this scheme function equitably, all countries would have to participate in this "unilateral carbon tax" scheme, since the tax would raise the prices of all commodities which use fossil fuel in some aspect of their production. To prevent any unfair trade advantage on the part of a country not assessing a carbon tax, often described as the "free rider" effect (Esty 1994a, Piggott et al. 1992), it might be necessary to add a tariff or "border-adjustment," imposed either by an international organization or the importing country, equivalent to the appropriate carbon tax on the "fuel component" of the product (von Moltke 1993). Some kind of a global

environmental organization would be necessary to oversee carbon taxes, carbon emission caps for individual countries and trade adjustments or sanctions (Esty 1994b). Either a new entity could be created or the functions could be best handled by an existing entity, such as UNEP, UNDP or the World Trade Organization.

Both tradeable permits and carbon taxes in effect place a cap on average per capita emissions. The first approach, with its emission caps for each country, creates incentives for countries to limit population size and therefore retain higher per capita usage limits, unless the caps are re-adjusted for changes in population. Carbon taxes, on the other hand, are perhaps the most equitable, but do not create incentives, other than economic, for any country or individual to reduce carbon emissions. Any population growth would effectively shrink the per capita carbon allotment, probably requiring an increase in the level of taxation to offset increased demand. For instance, with a global carbon budget of 4 GtC annually, carbon availability would shrink from .7 tons per person today to 0.4 tons per person in the middle of the 21st century, when the world population is expected to be 10 billion (Cline 1992b).

History strongly suggests that economic incentives like carbon taxes will be the most effective in achieving emission reductions. Since 1960, the only brief pauses in global emission increases have corresponded with large energy price increases or economic downturns. Carbon taxes similarly would affect demand through increased carbon-based energy prices, encouraging individuals and companies to use less energy or to substitute low or zero carbon emission fuels for higher ones. Quotas and tradeable permits may be conceptually viable and could be a part of the equation, but experience to date demonstrates that politics on the international and national scale is likely to derail, delay or weaken agreement and implementation.

VII. Conclusion: Equitably Averting the Tragedy of the Global Climate Commons

Ideally, a climate stabilization policy will equitably provide incentives for both individuals and nations to reduce their carbon emissions. As long as population continues to grow, however, the per capita emission budget must continue to decline, if global carbon emissions are to remain constant (Engelman 1994). Therefore, energy and climate stabilization policy should also be related to a population stabilization, to avoid a tragedy of the global climate commons (Goodland et al. 1994). Public scientific acknowledgment and explanation of the links between population, consumption and global warming would be an appropriate start, in the current atmosphere where family planning aid programs are being severely cut in the United States and other countries (Crossette 1996).

An effective and efficient strategy to achieve climate stabilization goals may be a combination of globally determined but unilaterally administered carbon taxes, and specific national caps based on population in a benchmark year, both enforced through international

trade mechanisms. This kind of scheme would allow the maximum use of free market forces and individual choice to determine how carbon emission reductions are achieved. Wherever possible, people should understand that their personal behavior affects the global environment and climate. The use of national caps will, however, also create a strong incentive for governments to strive for population stabilization so as to retain a higher per capita carbon emission budget.

Such a strategy is by no means a perfect or easy solution. The use of national caps could provide a disincentive for countries to permit net immigration above zero; it could also drive other countries to adopt oppressive means of population control. National caps would likely need to be adjusted with respect to population changes due to migration, or to respond to climate alterations in temperature, precipitation, agriculture and sea level. Each round of negotiations would be as lengthy and problematic as the current efforts. Precisely because of these inherent practical and political difficulties with national emission caps, I believe carbon taxes are an essential component of climate stabilization policy and probably should be the centerpiece of that policy.

As with many environmental problems, the carbon emissions puzzle involves balancing the rights of the individual against the rights of the human species, the rights of the present generation against those of future generations, and the rights of human beings against those of other species endangered by a changing climate. Because global warming is caused by the individual actions of virtually every person on the earth and will also affect them or their descendants, it requires a global solution. Internalizing the future costs of climate change into the present cost of carbon emissions and simultaneously encouraging nations to stabilize both population and emissions appears to be the most equitable, efficient solution, and can support other important global goals.

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How many people can the earth support?

Submitted by
Joel E Cohen

How Many People Can the Earth Support?

Joel E Cohen[1]

On April 25, 1679, in Delft, Holland, the inventor of the microscope, Antoni van Leeuwenhoek, wrote down what may be the first estimate of the maximum number of people the Earth can support. If all the habitable land in the world had the same population density as Holland (at that time about 120 people for every square kilometer), he calculated, the Earth could support at most 13.4 billion people — far fewer than the number of spermatozoans his lenses had revealed in the milt of a cod.

In subsequent centuries, van Leeuwenhoek's estimate has been followed by dozens of similar calculations. Around 1695 a Londoner named Gregory King estimated that the Earth's "Land If fully Peopled would sustain" at most 12.5 billion people. In 1765 a German regimental pastor, Johann Peter S"ssmilch, compared his own figure (13.9 billion) with the estimates of van Leeuwenhoek, the French military engineer SΘbastien Le Prestre de Vauban (5.5 billion) and the English writer and cartographer Thomas Templeman (11.5 billion).

In recent decades estimates of maximum population have appeared thicker and faster than ever before. Under the rubric of "carrying capacity" they crop up routinely in environmental debates, in United Nations reports and in papers by scholars or academic politicians trained in ecology, economics, sociology, geography, soil science or agronomy, among other disciplines. Demographers, however, have been strangely silent. Of the more than 200 symposiums held at the 1992 and 1993 annual meetings of the Population Association of America, not one session dealt with estimating or defining human carrying capacity for any region of the Earth. Instead, professional demographers tend to focus on the composition and growth of populations, restricting their predictions to the near term — generally a few decades into the future — and framing them in conditional terms: If rates of birth, death and migration (by age, sex, location, marital status and so on) are such-and-such, then population size and distribution will be so-and-so.

Such conditional predictions, or forecasts, can be powerful tools. Projections by the U.N. showed dramatically that if human populations continued to grow at 1990 rates in each major region of the world, then the population would increase more than 130-fold in 160 years, from about 5.3 billion in 1990 to about 694 billion in 2150. Those figures are

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extremely sensitive to the future level of average fertility. If, hypothetically, from 1990 onward the average couple gradually approached a level of fertility just one-tenth of a child more than required to replace themselves, world population would grow from 5.3 billion in 1990 to 12.5 billion in 2050 and 20.8 billion in 2150. In contrast, if (again hypothetically) starting in 1990 and ever after couples bore exactly the number of children needed to replace themselves, world population would grow from 5.3 billion in 1990 to 7.7 billion in 2050 and would level off around 8.4 billion by 2150.

The clear message is that people cannot forever continue to have, on average, more children than are required to replace themselves. That is not an ideological slogan; it is a hard fact. Conventional agriculture cannot grow enough food for 694 billion people; not enough water falls from the skies. The finiteness of the Earth guarantees that ceilings on human numbers do exist.

Where are those ceilings? Some people believe that any limit to human numbers is so remote that its existence is irrelevant to present concerns. Others declare that the human population has already exceeded what the Earth can support in the long run (how long is usually left unspecified). Still others concede that short-term limits may exist, but they argue that technologies, institutions and values will adapt in unpredictable ways to push ceilings progressively higher so that they recede forever. The differences of opinion are buttressed by vast disparities in calculation. In the past century, experts of various stripes have made estimates of human carrying capacity ranging from less than a billion to more than 1,000 billion. Who, if anybody, is right?

For several years I have been trying to understand the question, "How many people can the Earth support?" and the answers to it. In the process I came to question the question. "How many people can the Earth support?" is not a question in the same sense as "How old are you?"; it cannot be answered by a number or even by a range of numbers. The Earth's capacity to support people is determined partly by processes that the social and natural sciences have yet to understand, partly by choices that we and our descendants have yet to make.

In most of its various scientific uses, carrying capacity refers to a population of wild animals within a particular ecosystem. One widely used ecology textbook defines it as follows: "Number of individuals in a population that the resources of a habitat can support; the asymptote, or plateau, of the logistic and other sigmoid equations for population growth." Even within ecology, the concept of carrying capacity has important limitations. It applies best under stable conditions and over relatively short spans of time. In the real world, climates and habitats fluctuate and change; animals adapt to their conditions and eventually evolve into new species. With each change, the carrying capacity changes, too.

When applied to human beings, the concept becomes vastly more volatile. I have collected twenty-six definitions of human carrying capacity, all published since 1975. Most

of them agree on a few basic points — for instance, that the concept refers to the number of people who can be supported for some period (usually not stated) in some mode of life considered plausible or desirable. Most of the definitions recognize that ecological concepts of carrying capacity must be extended to allow for the role of technology. Most also agree that culturally and individually variable standards of living, including standards of environmental quality, set limits on population size well before the physical requirements for sheer subsistence start to become an issue.

In other respects, however, the definitions vary widely or even contradict one another. How long must a population be sustainable? Does it make sense to speak of local or regional carrying capacity — or do trade and the need for inputs from outside any specified region imply that only a global scale will do? More fundamental, how constraining are constraints? Some definitions deny the existence of any finite carrying capacity altogether, holding that human ingenuity will win out over any natural barriers; others acknowledge that the limits are real but recognize that human choices, now and in the future, will largely decide where those limits fall.

In my opinion, that last point — the interplay of natural constraints and human choices — is the key to making sense of human carrying capacity. The deceptively simple question "How many people can the Earth support?" hides a host of thorny issues:

How many people at what average level of material well-being?

The human carrying capacity of the Earth will obviously depend on the typical material level at which people choose to live. Material well-being includes food (people choose variety and palatability, beyond the constraints imposed by physiological requirements); fiber (people choose cotton, wool or synthetic fibers for clothing, wood pulp or rag for paper); water (tap water or Perrier or the nearest river or mud hole for drinking, washing, cooking and watering your lawn, if you have one); housing (Auschwitz barracks, two men to a plank, or Thomas Jefferson's Monticello); manufactured goods; waste removal (for human, agricultural and industrial wastes); natural-hazard protection (against floods, storms, volcanoes and earthquakes); health (prevention, cure and care); and the entire range of amenities such as education, travel, social groups, solitude, the arts, religion and communion with nature. Not all of those features are captured well by standard economic measures.

How many with what distribution of material well-being?

An ecologist, an economist and a statistician went bow hunting in the woods and spied a deer. The ecologist shot first, and his arrow landed five meters to the left of the deer. The economist shot next, and her arrow landed five meters to the right of the deer. The statistician looked at both arrows, looked at the deer, and jumped up and down shouting: "We got it! We got it!"

Estimates of human carrying capacity rarely take into account the scatter or distribution of material well-being throughout a population. Yet paying attention to average well-being while ignoring the distribution of well-being is like using an average arrow to kill a deer. People who live in extreme poverty may not know or care that the global average is satisfactory, and the press of present needs may keep them from taking a long-term view. For example, thanks to genetic engineering, any country with a few Ph.D.'s in molecular plant biology and a modestly equipped laboratory can insert the genes to create stronger, more disease-resistant, higher-yielding plants. If every region has the scientific and technical resources to improve its own crop plants, the Earth can support more people than it can if some regions are too poor to help themselves.

How many people with what technology?

The complexities of technological choices often disappear in heated exchanges between environmental pessimists and technological optimists:

Ecologist: When a natural resource is being consumed faster than it is being replenished or recycled, an asset is being depleted, to the potential harm of future generations.

Technologist: If new knowledge and technology can produce an equivalent or superior alternative, then future generations may turn out to be better off.

Taxpayer: Which natural resources can be replaced by technology yet to be invented, and which cannot? Will there be enough time to develop new technology and put it to work on the required scale? Could we avoid future problems, pain and suffering by making other choices now about technology or ways of living? [No answer from ecologist or technologist.]

The key to the argument is time. As Richard E. Benedick, an officer of the U.S. Department of State who has also served with the World-Wide Fund for Nature, worried: "While it is true that technology has generally been able to come up with solutions to human dilemmas, there is no guarantee that ingenuity will always rise to the task. Policymakers must contend with a nagging thought: 'what if it does not, or what if it is too late?'"

How many people with what domestic and international political institutions?

Political organization and effectiveness affect human carrying capacity. For example, the United Nations Development Program estimated that developing countries could mobilize for development as much as $50 billion a year (an amount comparable to all official development assistance) if they reduced military expenditures, privatized public enterprises, eliminated corruption, made development priorities economically more rational and improved national governance. Conversely, population size, distribution and composition affect political organization and effectiveness.

How will political institutions and civic participation evolve with increasing numbers ofpeople? As numbers increase, what will happen to people's ability to participate effectively in the political system?

What standards of personal liberty will people choose?

How will people bring about political change within existing nations? By elections and referendums, or by revolution, insurrection and civil war? How will people choose to settle differences between nations, for instance, over disputed borders, shared water resources or common fisheries? War consumes human and physical resources. Negotiation consumes patience and often requires compromise. The two options impose different constraints on human carrying capacity.

How many people with what domestic and international economic arrangements?

What levels of physical and human capital are assumed? Tractors, lathes, computers, better health and better education all make workers in rich countries far more productive than those in poor countries. Wealthier workers make more wealth and can support more people.

What regional and international trade in finished goods and mobility in productive assets are permitted or encouraged? How will work be organized? The invention of the factory organized production to minimize idleness in the use of labor, tools and machines. What new ways of organizing work should be assumed to estimate the future human carrying capacity?

How many people with what domestic and international demographic arrangements?

Almost every aspect of demography (birth, death, age structure, migration, marriage, and family structure) is subject to human choices that will influence the Earth's human carrying capacity.

A stationary global population will have to choose between a long average length of life and a high birth rate. It must also choose between a single average birth rate for all regions, on the one hand, and a demographic specialization of labor on the other (in which some areas have fertility above their replacement level, whereas other areas have fertility below their replacement level).

Patterns of marriage and household formation will also influence human carrying capacity. For example, the public resources that have to be devoted to the care of the young and the aged depend on the roles played by families. In China national law requires families to care for and support their elderly members; in the United States each elderly person and the state are largely responsible for supporting that elderly person.

How many people in what physical, chemical and biological environments?

What physical, chemical and biological environments will people choose for themselves and for their children? Much of the heat in the public argument over current environmental problems arises because the consequences of present and projected choices and changes are uncertain. Will global warming cause great problems, or would a global

limitation on fossil-fuel consumption cause greater problems? Will toxic or nuclear wastes or ordinary sewage sludge dumped in the deep ocean come back to haunt future generations when deep currents well up in biologically productive offshore zones, or would the long-term effects of disposing of those wastes on land be worse? The choice of particular alternatives could materially affect human carrying capacity.

How many people with what variability or stability?

How many people the Earth can support depends on how steadily you want the Earth to support that population. If you are willing to let the human population rise and fall, depending on annual crops, decadal weather patterns and long-term shifts in climate, the average population with ups and downs would include the peaks of population size, whereas the guaranteed level would have to be adjusted to the level of the lowest valley. Similar reasoning applies to variability or stability in the level of well-being; the quality of the physical, chemical and biological environments; and many other dimensions of choice.

How many people with what risk or robustness?

How many people the Earth can support depends on how controllable you want the well-being of the population to be. One possible strategy would be to maximize numbers at some given level of well-being, ignoring the risk of natural or human disaster. Another would be to accept a smaller population size in return for increased control over random events. For example, if you settle in a previously uninhabited hazardous zone (such as the flood plain of the Mississippi River or the hurricane-prone coast of the southeastern U.S.), you demand a higher carrying capacity of the hazardous zone, but you must accept a higher risk of catastrophe. When farmers do not give fields a fallow period, they extract a higher carrying capacity along with a higher risk that the soil will lose its fertility (as agronomists at the International Rice Research Institute in the Philippines discovered to their surprise).

How many people for how long?

Human carrying capacity depends strongly on the time horizon people choose for planning. The population that the Earth can support at a given level of well-being for twenty years may differ substantially from the population that can be supported for 100 or 1,000 years.

The time horizon is crucial in energy analysis. How fast oil stocks are being consumed matters little if one cares only about the next five years. In the long term, technology can change the definition of resources, converting what was useless rock to a valuable resource; hence no one can say whether industrial society is sustainable for 500 years.

Some definitions of human carrying capacity refer to the size of a population that can be supported indefinitely. Such definitions are operationally meaningless. There is no way of knowing what human population size can be supported indefinitely (other than zero population, since the sun is expected to burn out in a few billion years, and the human species

almost certainly will be extinct long before then). The concept of indefinite sustainability is a phantasm, a diversion from the difficult problems of today and the coming century.

How many people with what fashions, tastes and values?

How many people the Earth can support depends on what people want from life. Many choices that appear to be economic depend heavily on individual and cultural values. Should industrial societies use the available supplies of fossil fuels in households for heating and for personal transportation, or outside of households to produce other goods and services? Do people prefer a high average wage and low employment or a low average wage and high employment (if they must choose)?

Should industrial economies seek now to develop renewable energy sources, or should they keep burning fossil fuels and leave the transition to future generations? Should women work outside their homes? Should economic analyses continue to discount future income and costs, or should they strive to even the balance between the people now living and their unborn descendants?

I am frequently asked whether organized religion, particularly Roman Catholicism, is a serious obstacle to the decline of fertility. Certainly in some countries, Church policies have hindered couples' access to contraception and have posed obstacles to family planning programs. In practice, however, factors other than religion seem to be decisive in setting average levels of fertility for Roman Catholics. In 1992 two Catholic countries, Spain and Italy, were tied for the second- and third-lowest fertility rates in the world. In largely Catholic Latin America, fertility has been falling rapidly, with modern contraceptive methods playing a major role. In most of the U.S. the fertility of Catholics has gradually converged with that of Protestants, and polls show that nearly four-fifths of Catholics think that couples should make up their own minds about family planning and abortion.

Even within the church hierarchy, Catholicism shelters a diversity of views. On June 15, 1994, the Italian Bishops' conference issued a report stating that falling mortality and improved medical care "have made it unthinkable to sustain indefinitely a birthrate that notably exceeds the level of two children per couple." Moreover, by promoting literacy for adults, education for children and the survival of infants in developing countries, the church has helped bring about some of the social preconditions for fertility decline.

On the whole the evidence seems to me to support the view of the ecologist William W. Murdoch of the University of California, Santa Barbara: "Religious beliefs have only small, although sometimes significant, effects on family size. Even these effects tend to disappear with rising levels of well-being and education."

In short, the question "How many people can the Earth support?" has no single numerical answer, now or ever. Human choices about the Earth's human carrying capacity are constrained by facts of nature and may have unpredictable consequences. Consequently, estimates of human carrying capacity cannot aspire to be more than conditional and probable:

if future choices are thus-and-so, then the human carrying capacity is likely to be so-and-so. They cannot predict the constraints or possibilities that lie in the future; their true worth may lie in their role as a goad to conscience and a guide to action in the here and now.

The following beautiful quotation from Principles of Political Economy, by the English philosopher John Stuart Mill, sketches the kind of shift in values such action might entail. When it was written, in 1848, the world's population was less than one-fifth its present size.

"There is room in the world, no doubt, and even in old countries, for a great increase of population, supposing the arts of life to go on improving, and capital to increase. But even if innocuous, I confess I see very little reason for desiring it. The density of population necessary to enable mankind to obtain, in the greatest degree, all the advantages both of cooperation and of social intercourse, has, in all the most populous countries, been obtained. A population may be too crowded, though all be amply supplied with food and raiment. It is not good for man to be kept perforce at all times in the presence of his species. A world from which solitude is extirpated, is a very poor ideal. . . . Nor is there much satisfaction in contemplating the world with nothing left to the spontaneous activity of nature; with every rood of land brought into cultivation, which is capable of growing food for human beings; every flowery waste or natural pasture ploughed up, all quadrupeds or birds which are not domesticated for man's use exterminated as his rivals for food, every hedgerow or superfluous tree rooted out, and scarcely a place left where a wild shrub or flower could grow without being eradicated as a weed in the name of improved agriculture. If the Earth must lose that great portion of its pleasantness which it owes to things that the unlimited increase of wealth and population would extirpate from it, for the mere purpose of enabling it to support a larger but not a better or a happier population, I sincerely hope, for the sake of posterity, that they will content to be stationary, long before necessity compels them to it.

"It is scarcely necessary to remark that a stationary condition of capital and population implies no stationary state of human improvement. There would be as much scope as ever for all kinds of mental culture, and moral and social progress; as much room for improving the Art of Living, and much more likelihood of its being improved, when minds ceased to be engrossed by the art of getting on. Even the industrial arts might be as earnestly and as successfully cultivated, with this sole difference, that instead of serving no purpose but the increase of wealth, industrial improvements would produce their legitimate effect, that of abridging labour. . . . Only when, in addition to just institutions, the increase of mankind shall be under the deliberate guidance of judicious foresight, can the conquests made from the powers of nature by the intellect and energy of scientific discoverers, become the common property of the species, and the means of improving it and elevating the universal lot."

Note

Joel E. Cohen is Professor of Populations at Rockefeller University and at Columbia University in New York City. This article is adapted from his book, How Many People Can the Earth Support?, published in 1995 by W. W. Norton & Company, and is excerpted with the kind permission of the publisher. His paper "Conflicts Over World Population: Cairo and Beyond" recently appeared in the New York Academy of Sciences Science Policy Report "Science, Technology and New Global Realities: Issues for U.S. Foreign Policy."

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